United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
North Dakota Agricultural
Experiment Station, North
Dakota Cooperative
Extension Service, North
Dakota State Soil
Conservation Committee,
and United States
Department of the
Interior, Bureau of Indian
Affairs

Soil Survey of Mountrail County, North Dakota

How To Use This Soil Survey

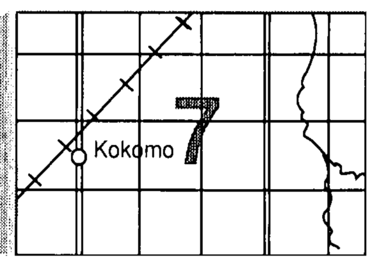
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

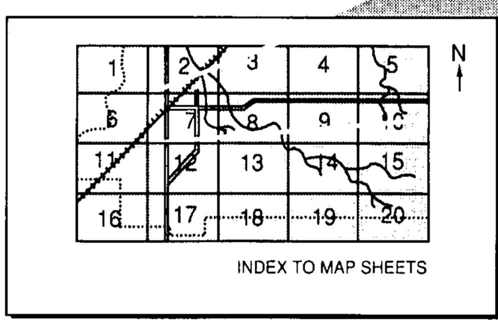
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

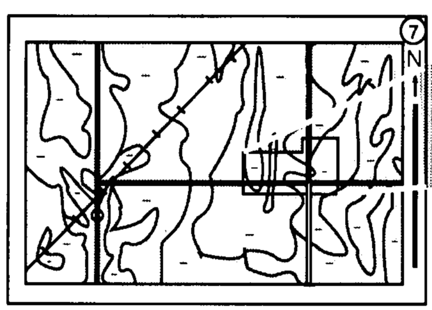


MAP SHEET

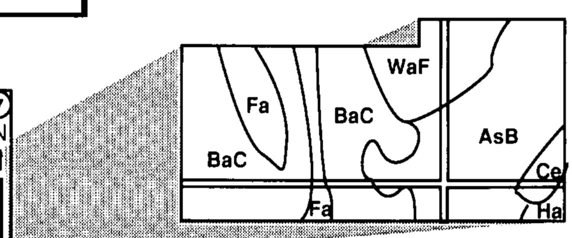
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1988. The flight for the photobase maps was in 1978. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station; North Dakota Cooperative Extension Service; United States Department of the Interior, Bureau of Indian Affairs; and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the Fort Berthold Soil Conservation District and the North Mountrail Soil Conservation District. Financial assistance was provided by the Mountrail County Board of Commissioners and the North Dakota Department of University and School Lands.

Cover: A cultivated area of Williams and Zahl soils in the foreground. Cabba and Shambo soils and Badland are in the background. They are used for range.

Contents

Issued June 1991

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Mountrail County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Ronnie L. Clark
State Conservationist
Soil Conservation Service

Soil Survey of Mountrail County, North Dakota

By Darrell VanderBusch, Soil Conservation Service

Fieldwork by Darrell VanderBusch, Jerome Schaar, Michael Sucik, Thomas Champa, James Moen, P. Michael Whited, and M. Robert Wright, Soil Conservation Service, and Wilhelm's Soil Consulting, Inc., Stoneman-Landers, Inc., and Wesley Larsen, professional soil classifiers

Map finishing by David W. Hickcox, Steven S. Kranich, and Juan E. Ramirez, North Dakota State Soil Conservation Committee

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, North Dakota State Soil Conservation Committee, and United States Department of the Interior, Bureau of Indian Affairs

MOUNTRAIL COUNTY is in the northwestern part of North Dakota (fig. 1). The county has a total area of 1,242,700 acres, or 1,934 square miles, of which 1,168,705 acres is land and 73,995 acres is water. Most of the water is Lake Sakakawea. The county is bounded on the south by Lake Sakakawea and McLean County, on the east by Ward County, on the north by Ward and Burke Counties, and on the west by Williams County. Stanley, the county seat, is in the central part of the county.

The first soil survey of Mountrail County was published in 1910 *(10)*. A general soil survey of the county was published in 1968 *(11, 12)*. The present survey updates the earlier surveys. It provides additional information and larger scale maps, which show the soils in more detail.

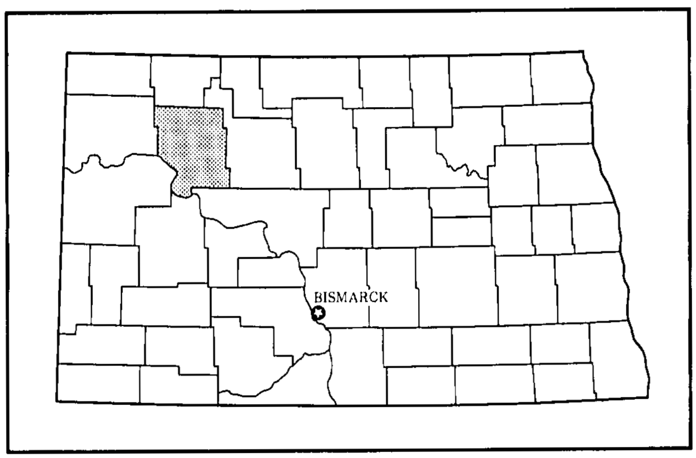


Figure 1.—Location of Mountrail County in North Dakota.

General Nature of the County

This section provides general information about the county. It describes climate; history and development; farming and ranching; geology, physiography, and drainage; and natural resources.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Mountrail County is usually quite warm in summer. Frequent spells of hot weather and occasional cool

days occur during the summer. The county is very cold in winter, when arctic air frequently surges over the area. Most of the precipitation falls during the warm period. It is normally heaviest in late spring and early summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Stanley in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 10 degrees F and the average daily minimum temperature is -4 degrees. The lowest temperature on record, which occurred at Stanley on December 24, 1983, is -47 degrees. In summer, the average temperature is 65 degrees and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Stanley on July 20, 1960, is 105 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 18 inches. Of this, 14 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.25 inches at Stanley on June 18, 1956. Thunderstorms occur on about 34 days each year.

The average seasonal snowfall is about 40 inches. The greatest snow depth at any one time during the period of record was 30 inches. On the average, 43 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 12 miles per hour, in spring.

Several times each winter, storms with snow and high wind bring blizzard conditions to the area. Hail falls in small scattered areas during summer thunderstorms.

History and Development

The first settlers in what is now Mountrail County were fur traders and ranchers. They arrived in the early 1800's. The Lewis and Clark explorations reached the southern boundary of the county along the Missouri River in 1805. The Indian tribes that inhabited the survey area when the settlers arrived were the Assinniboins, Hidatsa, Arikara, Mandans, and Sioux.

The southern part of Mountrail County was set up as an Indian reservation by a treaty in 1851. With the coming of the railroads in the 1870's, the reservation boundary was moved to south of Plaza. In 1910, it was again moved to its present location south of New Town. After the reservation boundary was moved on these two occasions, more land was opened up for homesteading.

When the railroads extended into the survey area, people from Minnesota, Iowa, and Nebraska and from northern Europe and Syria settled in large numbers. Land was obtained from the railroad and from the government through the Homestead Act. In 1908, the present boundaries of the county were established. Stanley was made the county seat in the same year *(8)*.

The population of Mountrail County was 12,140 by 1920 and 13,544 by the 1930's. It began to decline in the 1930's because of drought and economic depression *(15)*. In 1980, the population was 7,679. In that year, Stanley, the largest town in the county, had a population of 1,631. Other communities include Palermo, Ross, White Earth, Plaza, Parshall, Blaisdell, Tagus, New Town, Beldon, Lostwood, Sanish, and Coulee.

Farming and Ranching

Ranching was the main agricultural enterprise in Mountrail County in the 1880's. The development of farming progressed rapidly throughout the county from the 1880's to 1920's. In 1950, the county had 1,484 farms. From 1950 to 1986, the number of farms decreased to 1,006.

The main crop grown in Mountrail County is durum wheat. Other important crops are spring wheat, barley, sunflowers, oats, safflower, flax, and grass-legume hay. Sunflowers and safflower have become important cash crops in the last few years. They are grown mainly for oil production. Barley is grown for feed and malting.

About 56 percent of the county is cropland, 36 percent is range or pasture, 6 percent is areas of water, and 2 percent is woodland, federal and state land, or other land. Raising livestock is a major enterprise, as is indicated by the acreage of range and pasture.

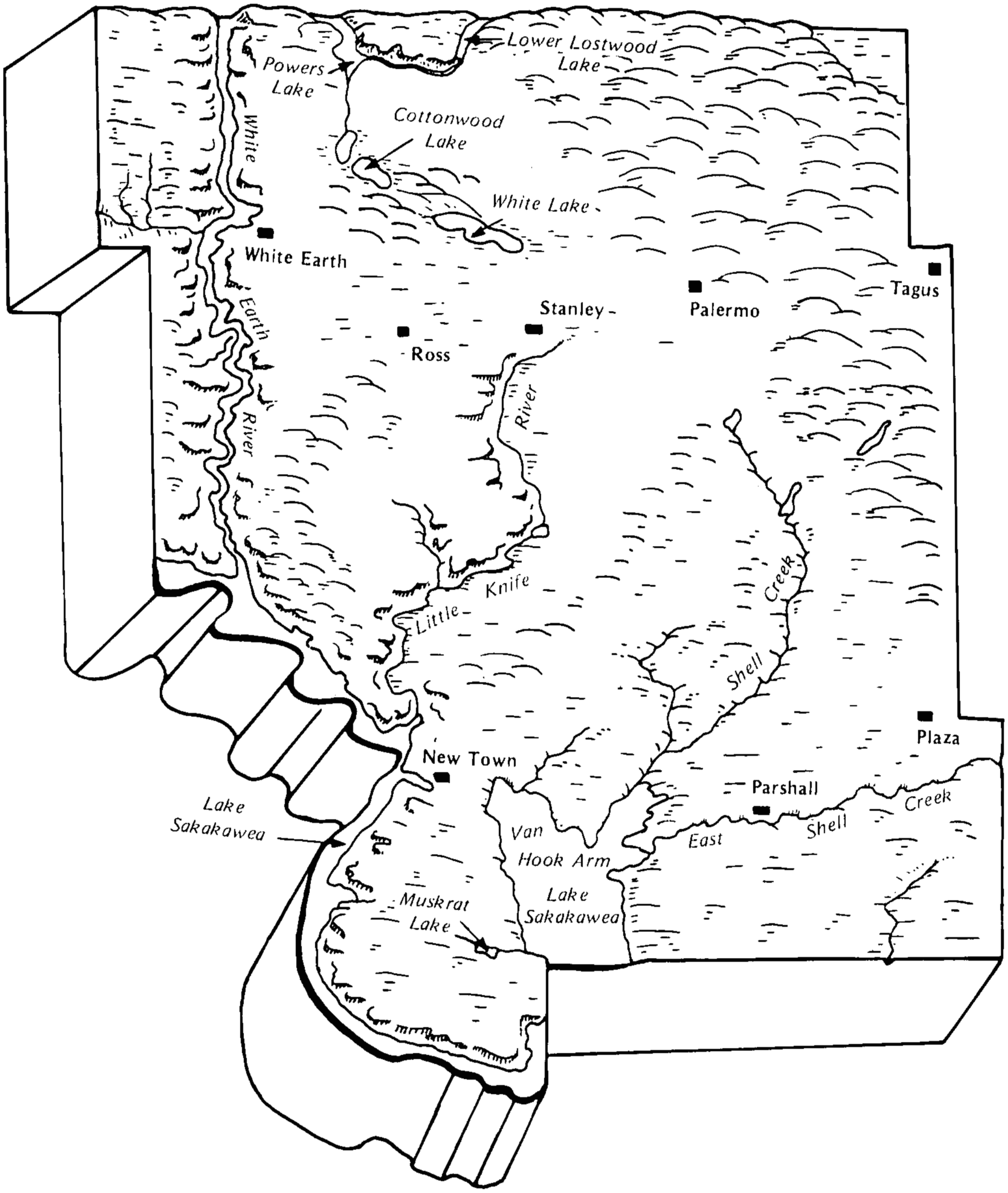


Figure 2.—Physiographic features of Mountrail County.

Three soil conservation districts were established in Mountrail County in 1943. In 1961, the number of districts was reduced to two. These are the North Mountrail Soil Conservation District and the Fort Berthold Soil Conservation District.

Geology, Physiography, and Drainage

The northeast corner of Mountrail County is in the Central Lowland Province, and the rest of the county is in the Great Plains Province (fig. 2). The county can be

divided into five general topographic areas. The northeastern part is the Drift Prairie, which is a level area covering much of the northeastern half of North Dakota. The Missouri Escarpment separates the Drift Prairie from the Missouri Coteau. It is a smooth slope that rises from an elevation of 2,100 feet at the edge of the Drift Prairie to about 2,250 feet at the top of the escarpment. The Missouri Coteau is a hilly area that extends from east-central South Dakota northwestward into western Saskatchewan. Sloping southwestward from the Missouri Coteau is the Coteau Slope. The land surface ranges from gently rolling to hilly. At the southwestern edge of Mountrail County is the Missouri River trench. The sides of the trench consist of badland bluffs, and the bottom of the trench is occupied by Lake Sakakawea, which is at an elevation of about 1,850 feet.

The Coteau Slope is drained by several tributaries of the Missouri River. These tributaries form the major watersheds in Mountrail County. The White Earth River flows from north to south along the western edge of the county. The Little Knife River originates near the town of Stanley. It flows to the southwest and drains the west-central part of the Coteau Slope. Shell Creek drains the eastern part of the county, and East Shell Creek and Deepwater Creek drain the southeastern part.

The Missouri Coteau is characterized by interior drainage. It has numerous sloughs and lakes but has no streams. This hilly area is commonly referred to as "pothole country" because of its closed drainage. The entire 20-mile width of this area is the continental divide between drainage into the Gulf of Mexico and drainage into Hudson Bay. Local drainageways and streams on the Drift Prairie and Missouri Escarpment flow northeast into the DesLacs River *(7)*.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for crops and the grasses grazed by livestock. Oil, natural gas, lignite coal, and sand and gravel are also important resources.

Most of the county has adequate water supplies for domestic uses and for use by livestock. The water is obtained from aquifers in glacial drift and from coal veins and the deeper part of the Dakota aquifer. Aquifers with the best potential for development are the sand and gravel deposits that form the New Town and Shell Creek aquifers. The two aquifers yield 200 to as much as 500 gallons of water per minute. Care is required to ensure that both the soils and the water are suitable for sustained irrigation. Lake Sakakawea also contains large reserves of suitable water. Because the flow of water is low and the content of soluble salts is high, water from streams is of limited value, except for use by livestock *(3)*.

In the 1950's, oil and natural gas were discovered in Mountrail County. Scattered oil fields are now in production in the northwest corner of the county, east and south of Stanley, and near Plaza. The county has an estimated 1 billion tons of lignite coal reserves. Because of the thick overburden, there is no commercial mining for lignite coal.

Sand and gravel are being mined in the county. They are used mainly for surfacing secondary roads and as a base for paved highways. Because the quality of the deposits varies, onsite investigation is needed.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of

soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such

landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures followed in making this survey are described in the National Soils Handbook of the Soil Conservation Service. The references consulted are listed near the end of this publication.

All soil mapping was done on field sheets developed from high-altitude aerial photographs taken in 1978. The scale of the field sheets was 1:20,000, or 3.168 inches to the mile. The detail of these field sheets was checked against older aerial photographs and in some instances against topographic maps.

Traverses were made on foot, by pickup truck with a mounted bull probe, and by three- and four-wheel, all-terrain vehicles at an interval close enough to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas of the units. One transect was required for each 1,000 acres of the map unit with a minimum of 2 transects and a maximum of about 10. Additional transects were recorded for some map units to justify names and establish the range of composition of the unit. For each map unit, the minimum documentation consisted of three pedon descriptions for each soil series used in its name. The transect data were analyzed by a statistical method explained by R.W. Arnold *(4)*.

Soil characterization or engineering test data samples were collected from 30 soil pedons during the period of 1982 to 1988. The analyses were made by the North Dakota State University Soil Characterization Laboratory and by the North Dakota State Highway Department.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries and soil names on the general soil map of Mountrail County do not match those on the maps of McLean and Ward Counties. The differences are a result of improvements in the classification of soils, particularly modifications or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey areas.

Soil Descriptions

Deep, Loamy Soils Formed in Glacial Till and Alluvium

These soils are on till plains and moraines. They make up about 85 percent of the county. Most areas are used for range or cultivated crops, but some are used for pasture. The soils are well suited to range and pasture and are suited to cultivated crops. The main concern in managing range and pasture is maintaining an adequate cover of the important range or suitable pasture plants. The main concern in managing cultivated areas is controlling soil blowing and water erosion.

1. Williams-Hamerly-Bowbells Association

Deep, medium textured, level and nearly level, well drained to somewhat poorly drained soils

This association consists of level and nearly level soils on flats and rises and in swales on till plains. The landscape is dotted with depressions and knolls. Slope ranges from 0 to 3 percent.

This association makes up about 5 percent of the county. It is about 60 percent Williams soils, 10 percent Hamerly soils, 5 percent Bowbells soils, and 25 percent soils of minor extent (fig. 3).

The nearly level, well drained Williams soils are on flats and rises. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam.

The level and nearly level, somewhat poorly drained Hamerly soils are on flats adjacent to the depressions. Typically, the surface layer is dark gray loam about 8 inches thick. The subsoil is very pale brown, mottled loam about 26 inches thick. The substratum to a depth of about 60 inches is light yellowish brown loam.

The level and nearly level, moderately well drained Bowbells soils are in swales and on flats. Typically, the surface layer is loam about 7 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The subsoil is clay loam about 53 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light gray in the lower part.

Farnuf, Parnell, Tonka, and Zahl are the principal minor soils in this association. The Farnuf soils have a loam surface layer and a silty clay loam substratum. They are on flats. The Parnell soils are very poorly drained. They are in deep depressions. The Tonka soils are poorly drained. They are in shallow depressions. The Zahl soils have a subsoil that is calcareous throughout. They are on knolls.

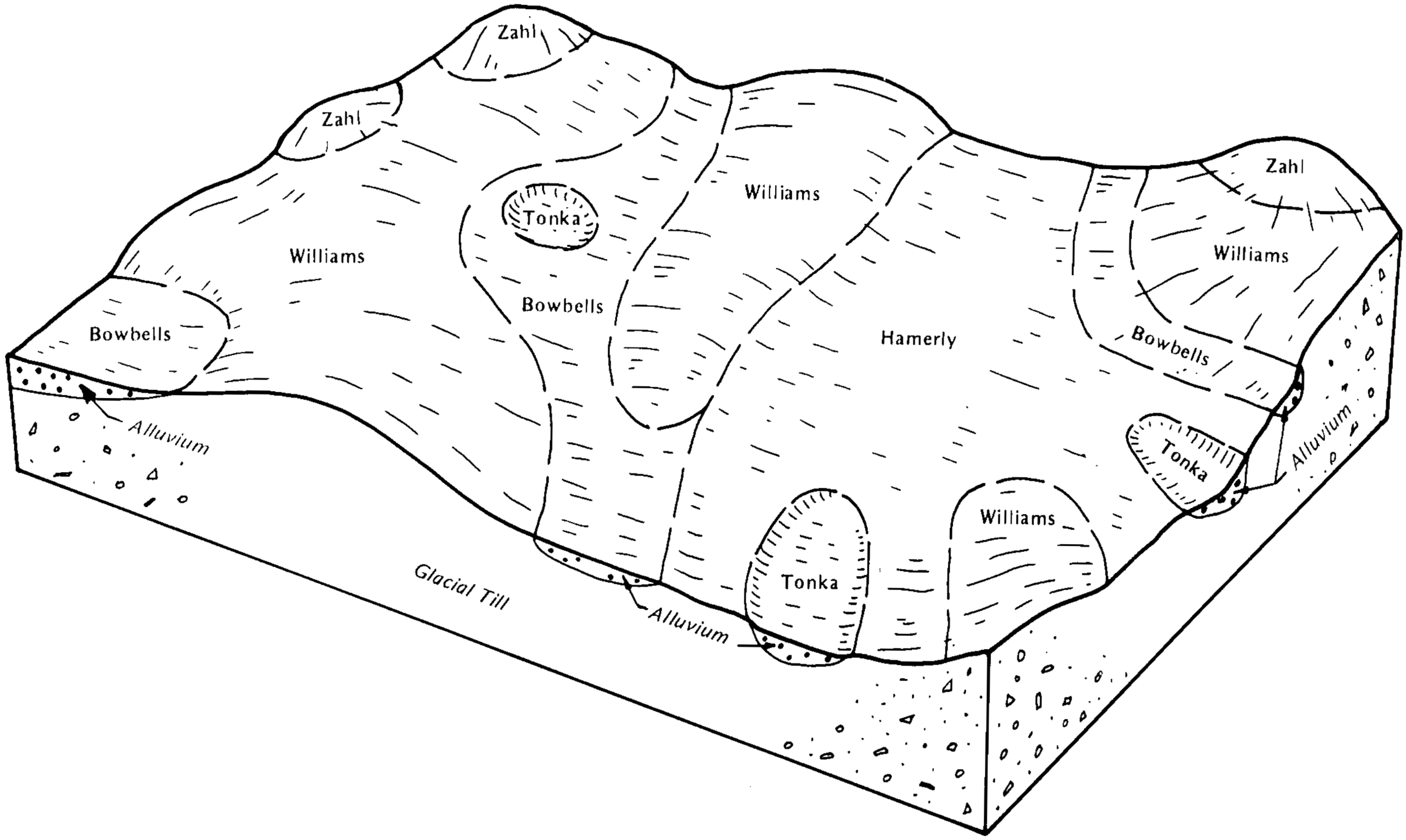


Figure 3.—Typical pattern of soils and parent material in the Williams-Hamerly-Bowbells association.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The main concerns in managing cultivated areas are maintaining tilth and fertility on the Williams and Bowbells soils and controlling soil blowing on the Hamerly soils. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

The minor Tonka and Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wetland wildlife habitat are preventing siltation and maintaining the natural water level.

2. Williams-Zahl Association

Deep, medium textured, undulating and gently rolling, well drained soils

This association consists of undulating and gently rolling soils on side slopes, shoulder slopes, summits, low ridges, and knolls on till plains. The landscape is dotted with depressions, swales, and flats. Slope ranges from 3 to 9 percent.

This association makes up about 35 percent of the county. It is 55 percent Williams soils, 20 percent Zahl soils, and 25 percent soils of minor extent (fig. 4).

The Williams soils are on side slopes and summits. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam.

The Zahl soils are on shoulder slopes, low ridges, and knolls. Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam.

Bowbells, Farnuf, Parnell, Tonka, and Vebar are the

principal minor soils in this association. The Bowbells soils are moderately well drained. They are in swales. The Farnuf soils have a loam surface layer and a silty clay loam substratum. They are on flats. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained. The Vebar soils are moderately deep. They are on side slopes.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The main concern in managing cultivated areas is controlling soil blowing on the Zahl soils and water erosion on the Williams and Zahl soils. The main concerns in managing range or pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

The minor Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wetland wildlife habitat are preventing siltation and maintaining the natural water level.

3. Zahl-Williams Association

Deep, medium textured, gently rolling to hilly, well drained soils

This association consists of gently rolling to hilly soils on knolls, shoulder slopes, ridges, summits, and side slopes on moraines. The landscape is dotted with depressions, swales, and flats. Slope ranges from 6 to 25 percent.

This association makes up about 45 percent of the county. It is about 40 percent Zahl soils, 30 percent Williams soils, and 30 percent soils of minor extent (fig. 5).

The Zahl soils are on shoulder slopes, ridges, and knolls. Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam.

The Williams soils are on side slopes and summits. Typically, the surface layer is dark grayish brown loam

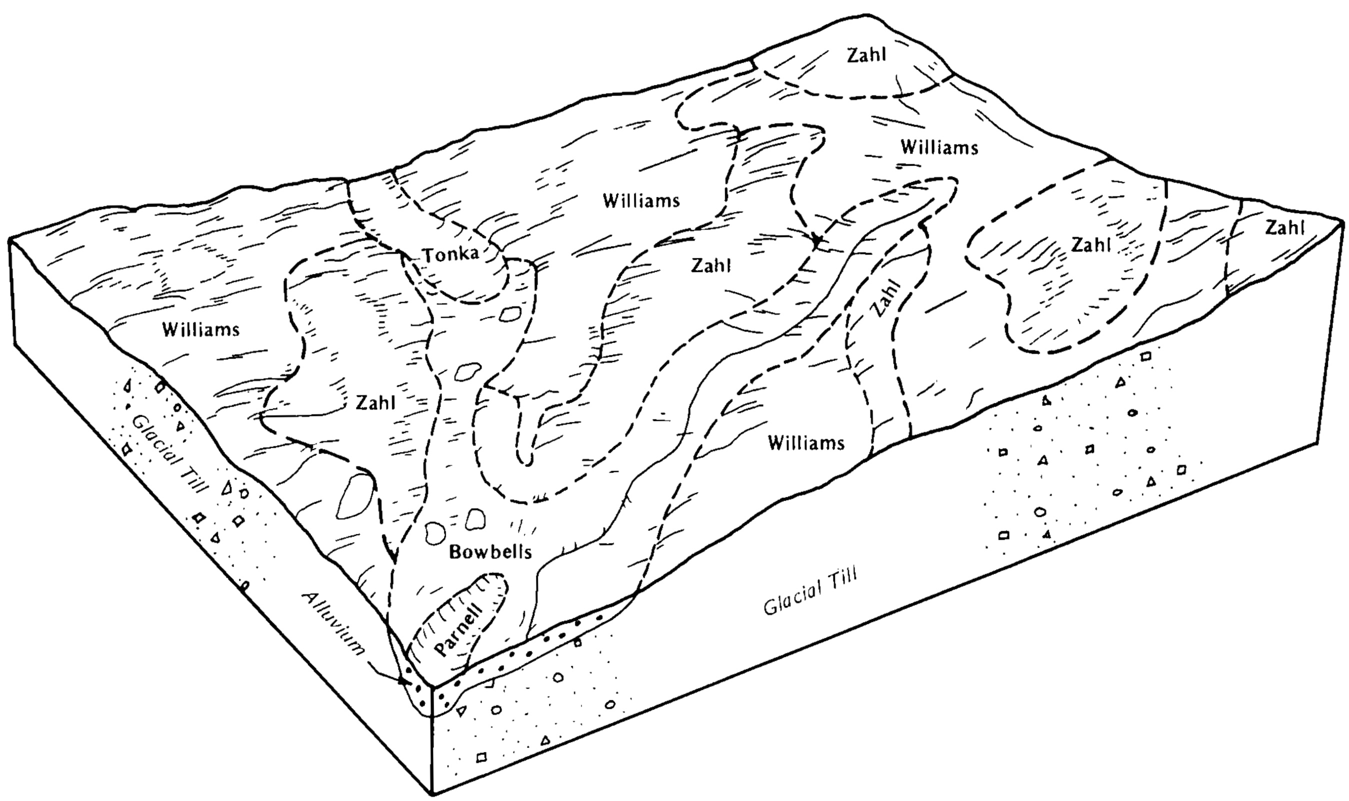


Figure 4.—Typical pattern of soils and parent material in the Williams-Zahl association.

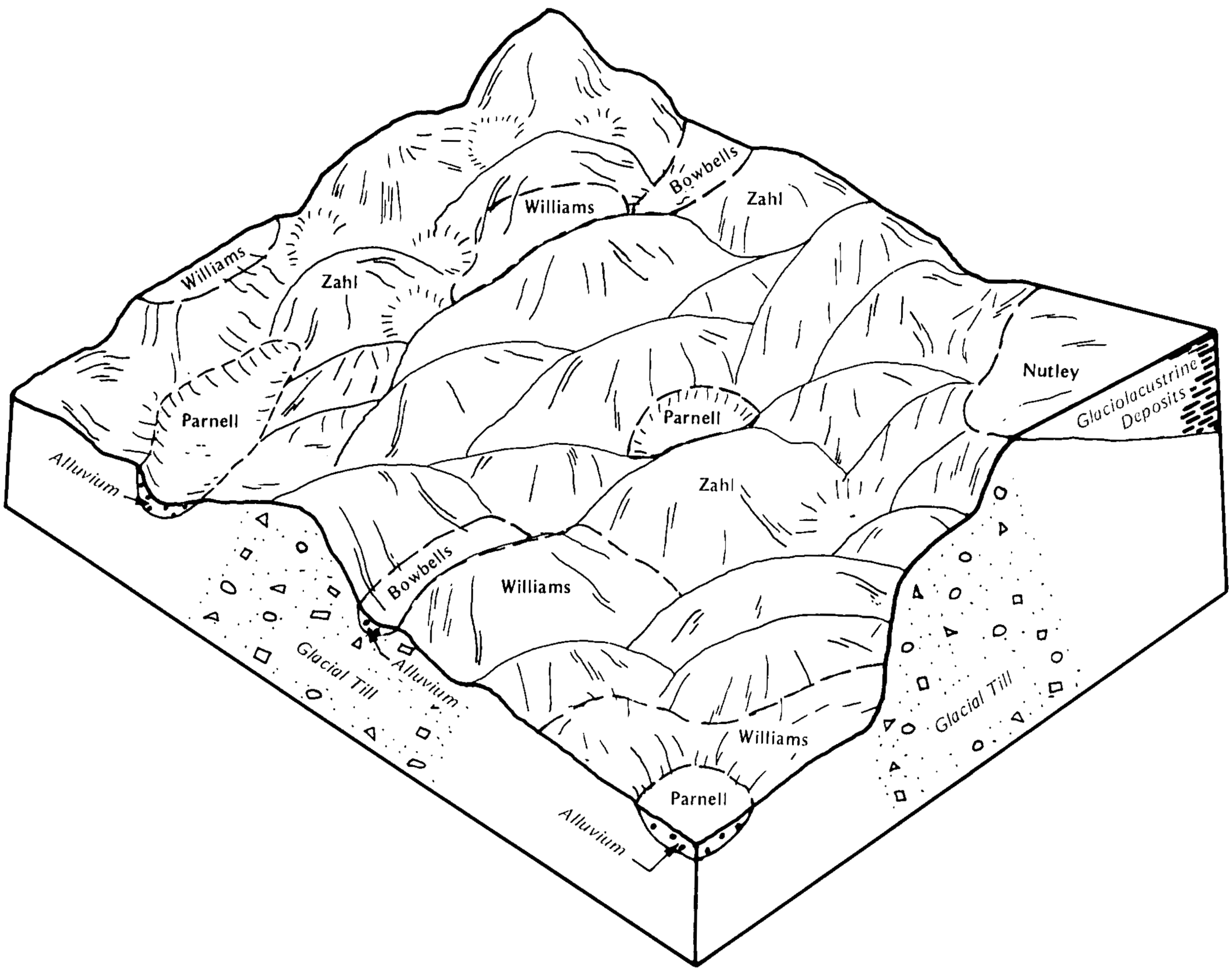


Figure 5.—Typical pattern of soils and parent material in the Zahl-Williams association.

about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam.

Bowbells, Nutley, Parnell, Southam, and Wabek are the principal minor soils in this association. The Bowbells soils are moderately well drained. They are in swales. The Nutley soils have a silty clay surface layer and subsoil. They are on flats. The Parnell soils are very poorly drained. They are in depressions. The Southam soils are nearly continuously ponded. They are in deep depressions. The Wabek soils have sand and gravel within 12 inches of the surface. They are on ridges and knolls.

Most areas are used for range, but some of the less sloping areas are used for cultivated crops or hay. The soils are suited to these uses. The main concern in managing cultivated areas is controlling soil blowing on the Zahl soils and water erosion on the Zahl and Williams soils. The main concerns in managing range or pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

The minor Parnell and Southam soils are best suited to wetland wildlife habitat. The main concerns in managing wetland wildlife habitat are preventing

siltation and maintaining the natural water level.

Deep, Loamy, Silty, and Clayey Soils Formed in Glaciolacustrine Deposits

These soils are on lake plains. They make up about 3 percent of the county. Most areas are used for cultivated crops, but some areas are used for range or pasture. The soils are well suited to these uses. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range and pasture is maintaining an adequate cover of the important range or suitable pasture plants.

4. Farnuf-Makoti Association

Deep, medium textured and moderately fine textured, nearly level and gently sloping, well drained and moderately well drained soils

This association consists of nearly level and gently sloping soils on flats and rises on lake plains. Slope ranges from 1 to 6 percent.

This association makes up about 1 percent of the county. It is about 65 percent Farnuf soils, 20 percent Makoti soils, and 15 percent soils of minor extent (fig. 6).

The nearly level and gently sloping, well drained Farnuf soils are on flats and rises. Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 36 inches thick. In sequence downward, it is brown loam; yellowish brown loam; light yellowish brown, mottled loam; pale yellow, mottled clay loam; and pale yellow, mottled silty clay loam. The

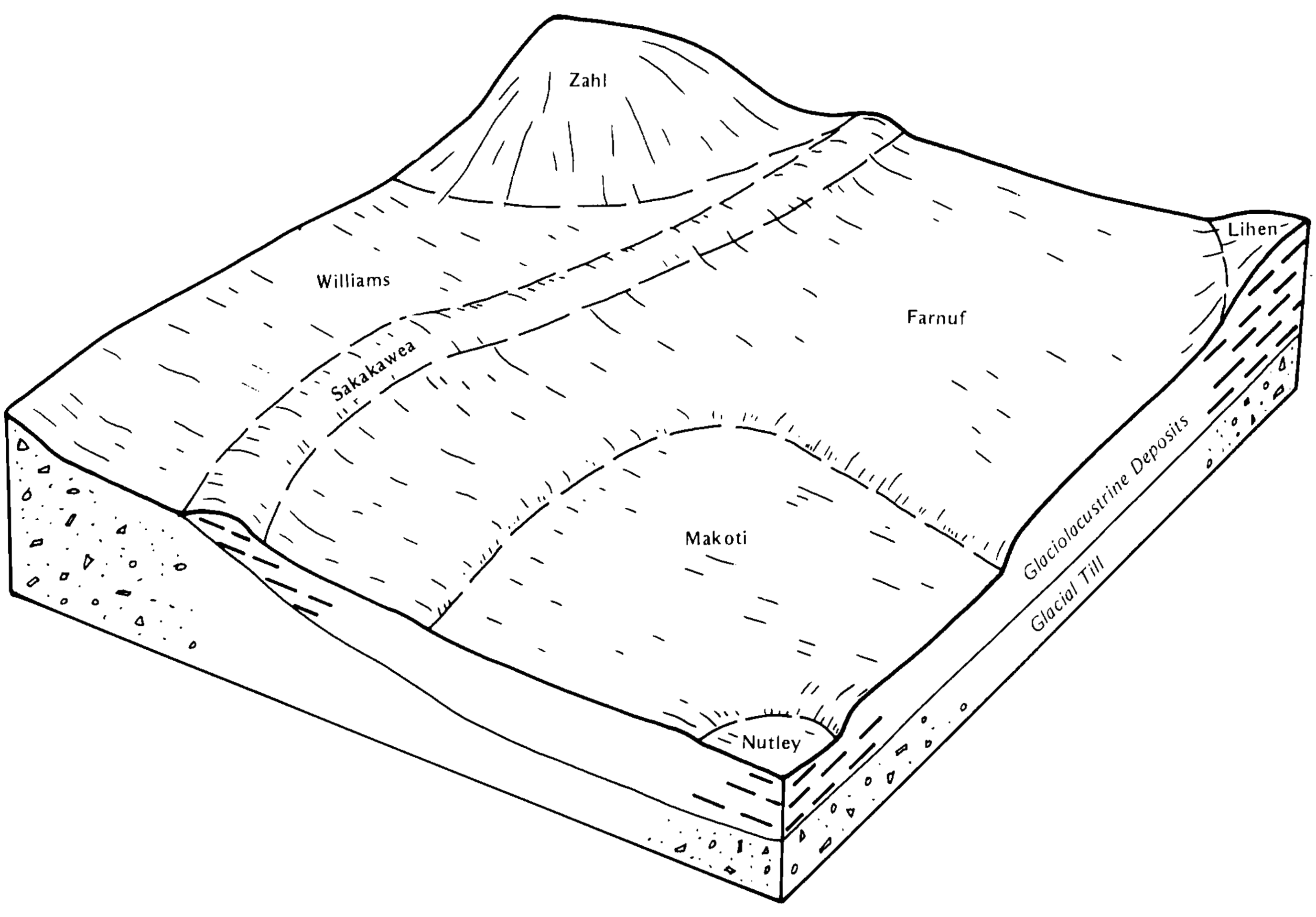


Figure 6.—Typical pattern of soils and parent material in the Farnuf-Makoti association.

upper part of the substratum is stratified pale yellow and light gray, mottled silty clay loam. The lower part to a depth of about 60 inches is stratified light gray and reddish yellow silty clay loam.

The nearly level, moderately well drained Makoti soils are on flats. Typically, the surface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. It is dark grayish brown silty clay loam in the upper part, grayish brown silty clay loam in the next part, and light brownish gray, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is light yellowish brown, mottled clay loam.

Lihen, Nutley, Sakakawea, Williams, and Zahl are the principal minor soils in this association. The Lihen soils have a loamy sand surface layer. They are on flats and rises. The Nutley soils have a silty clay surface layer and subsoil. They are intermingled with areas of the Farnuf soils. The Sakakawea soils are calcareous throughout. They are on flats and ridges. The Williams soils formed in glacial till. They are on side slopes. The Zahl soils have a subsoil that is calcareous throughout. They are on ridges.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The main concerns in managing cultivated areas are maintaining tilth and fertility and controlling water erosion and soil blowing. The minor Lihen, Nutley, Sakakawea, Williams, and Zahl soils are subject to soil blowing. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

5. Nutley Association

Deep, fine textured, nearly level and gently sloping, well drained soils

This association consists of nearly level and gently sloping soils on side slopes and flats on lake plains. Slope ranges from 1 to 6 percent.

This association makes up about 2 percent of the county. It is about 75 percent Nutley soils and 25 percent soils of minor extent.

The Nutley soils are on side slopes and flats. Typically, the surface layer is dark gray silty clay about 5 inches thick. The subsoil is grayish brown silty clay about 21 inches thick. The next layer is grayish brown silty clay about 10 inches thick. The substratum to a depth of about 60 inches is light olive gray clay.

Farnuf, Sakakawea, Williams, and Zahl are the principal minor soils in this association. The Farnuf soils have a loam surface layer and a silty clay loam substratum. They are intermingled with areas of the Nutley soils. The Sakakawea soils have a silt loam subsoil. They are on rises and ridges. The Williams soils have a loam surface layer and a clay loam subsoil. They are on side slopes and flats. The Zahl soils have a clay loam substratum. They are on ridges and knolls.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

Deep, Loamy and Sandy Soils Formed in Glaciofluvial Deposits, Eolian Deposits, Glaciolacustrine Deposits, and Glacial Till

These soils are on terraces, outwash plains, lake plains, and mantled till plains. They make up about 2 percent of the county. Most areas are used for cultivated crops or range, but some are used for pasture. The soils are well suited to range and pasture and are suited to cultivated crops. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and overcoming droughtiness. The main concern in managing range or pasture is maintaining an adequate cover of the important range or suitable pasture plants.

6. Manning-Livona-Lihen Association

Deep, moderately coarse textured and coarse textured, nearly level to moderately sloping, somewhat excessively drained and well drained soils

This association consists of nearly level to moderately sloping soils on flats, knolls, and side slopes on terraces, outwash plains, lake plains, and mantled till plains. Slope ranges from 1 to 9 percent.

This association makes up about 1 percent of the county. It is about 55 percent Manning soils, 15 percent Livona soils, 10 percent Lihen soils, and 20 percent soils of minor extent (fig. 7).

The nearly level and gently sloping, somewhat excessively drained Manning soils are on flats and side slopes. Typically, the surface layer is dark grayish brown sandy loam about 7 inches thick. The subsoil is sandy loam about 16 inches thick. It is dark grayish brown in the upper part, brown in the next part, and very pale brown and pale brown in the lower part. The substratum to a depth of about 60 inches is light yellowish brown very gravelly sand.

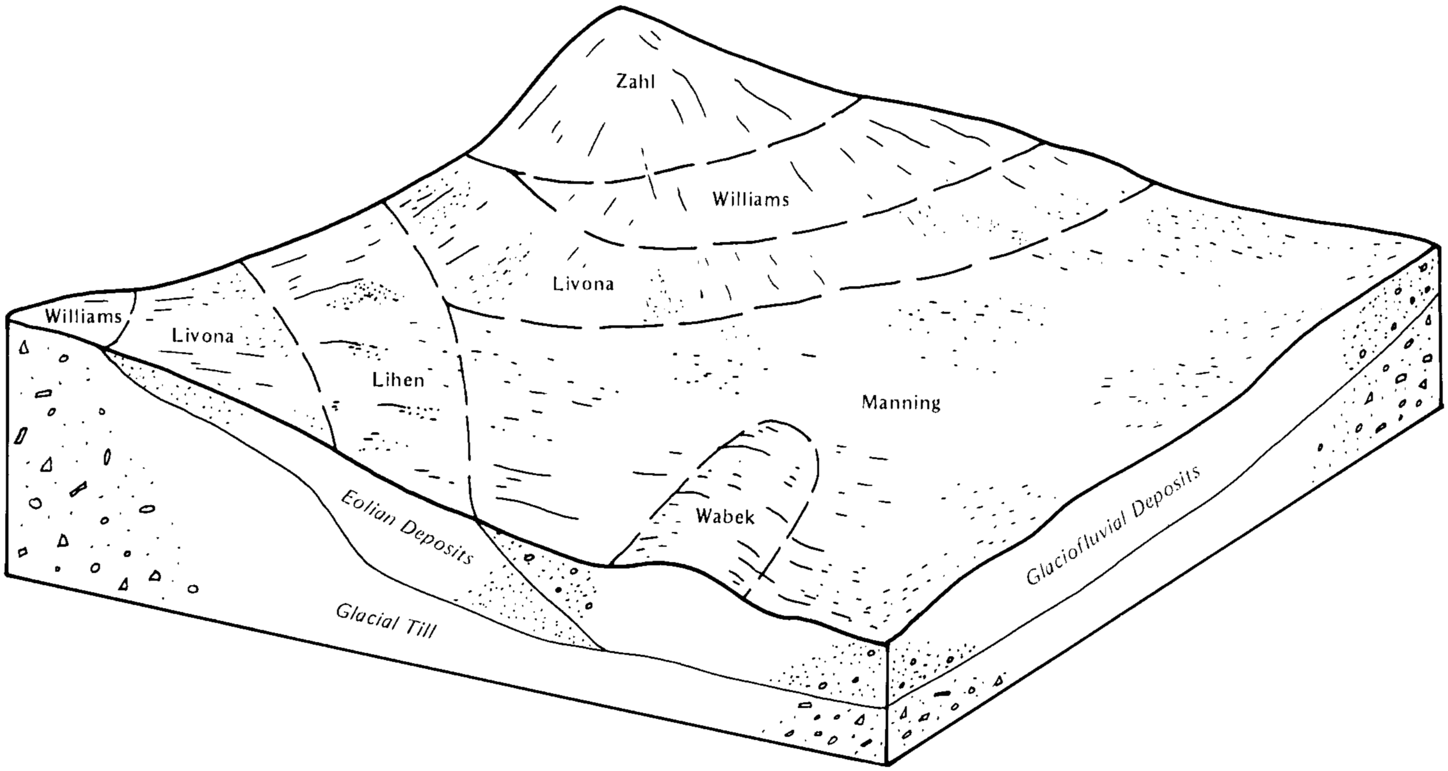


Figure 7.—Typical pattern of soils and parent material in the Manning-Livona-Lihen assocation.

The nearly level and gently sloping, well drained Livona soils are on flats and side slopes. Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsoil is about 30 inches thick. In sequence downward, it is brown sandy loam; brown sandy clay loam; grayish brown, mottled clay loam; light olive brown, mottled clay loam; and light brownish gray clay loam. The substratum to a depth of about 60 inches is light brownish gray clay loam.

The nearly level to moderately sloping, well drained Lihen soils are on knolls and the side slopes. Typically, the surface soil is loamy sand or sandy loam about 20 inches thick. It is brown in the upper part and very dark grayish brown in the lower part. The next layer is brown sand about 10 inches thick. The upper part of the substratum is light brownish gray sand, the next part is light yellowish brown fine sand, and the lower part to a depth of about 60 inches is light yellowish brown clay loam.

Divide, Wabek, Williams, and Zahl are the principal minor soils in this association. The Divide soils are somewhat poorly drained and highly calcareous. They are in swales. The Wabek soils have sand and gravel within 12 inches of the surface. They are on ridges and knolls. The Williams soils have a loam surface layer and clay loam subsoil. They are on side slopes. The Zahl soils have a clay loam substratum. They are on knolls and ridges.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

7. Wabek-Lehr Association

Deep, medium textured, nearly level to steep, excessively drained and somewhat excessively drained soils

This association consists of nearly level to steep soils on flats, side slopes, knolls, and ridges on outwash

plains and terraces. Slope ranges from 1 to 35 percent.

This association makes up about 1 percent of the county. It is about 55 percent Wabek soils, 25 percent Lehr soils, and 20 percent soils of minor extent.

The nearly level to steep, excessively drained Wabek soils are on knolls and ridges. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is grayish brown gravelly coarse sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is light brownish gray very gravelly coarse sand.

The nearly level and gently sloping, somewhat excessively drained Lehr soils are on flats and side slopes. Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is about 16 inches thick. It is dark grayish brown loam in the upper part, pale brown loam in the next part, and light yellowish brown and white gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is light brownish gray and pale yellow very gravelly coarse sand.

Bowdle, Divide, Williams, and Zahl are the principal minor soils in this association. The Bowdle and Divide soils are in swales. The Bowdle soils are well drained and are 20 to 33 inches deep to sand and gravel. The Divide soils are somewhat poorly drained and highly calcareous. The Williams soils are well drained and have a loam surface layer and a clay loam subsoil. They are on side slopes. The Zahl soils have a clay loam substratum. They are on knolls and ridges.

Most areas are used for range, but some of the less sloping areas are used for cultivated crops or hay. The Lehr soils are suited to these uses. The Wabek soils are best suited to range. The main concerns in managing cultivated areas are controlling water erosion and overcoming droughtiness. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

Deep, Loamy and Silty Soils Formed in Alluvium

These soils are on terraces and fans. They make up about 2 percent of the county. Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The Rhoades soils are best suited to range. The main concern in managing cultivated areas is controlling water erosion. The main concern in managing range or pasture is maintaining an adequate cover of the important range or suitable pasture plants.

8. Shambo-Rhoades-Savage Association

Deep, medium textured and moderately fine textured, nearly level to moderately sloping, well drained and moderately well drained soils

This association consists of nearly level to moderately sloping soils on side slopes, flats, and summits on terraces and fans. Most areas are crossed by shallow drainageways. In some areas the drainageways are entrenched. Slope ranges from 1 to 9 percent.

This association makes up about 2 percent of the county. It is about 40 percent Shambo soils, 20 percent Rhoades soils, 20 percent Savage soils, and 20 percent soils of minor extent.

The nearly level to moderately sloping, well drained Shambo soils are on side slopes and summits. Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is loam about 42 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is grayish brown loam.

The nearly level and gently sloping, moderately well drained, alkali Rhoades soils are on flats and side slopes. Typically, the surface layer is light brownish gray loam about 3 inches thick. The subsoil is grayish brown clay loam about 22 inches thick. The next layer is light brownish gray loam about 7 inches thick. The substratum to a depth of about 60 inches is light gray loam.

The nearly level and gently sloping, well drained Savage soils are on flats and side slopes. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 43 inches thick. In sequence downward, it is dark grayish brown silty clay, grayish brown silty clay, light brownish gray silty clay, and light brownish gray silty clay loam. The substratum to a depth of about 60 inches is light brownish gray clay loam.

Belfield, Cabba, Harriet, and Lehr are the principal minor soils in this association. The Belfield and Lehr soils are on flats. The Belfield soils have an alkali subsoil. The Lehr soils are 14 to 20 inches deep to sand and gravel. The Cabba soils are shallow. They are on steep side slopes. The poorly drained Harriet soils have a dense, alkali subsoil. They are in swales.

Most areas are used for cultivated crops, but some are used for range or pasture. The soils are suited to these uses. The Rhoades soils and the minor Cabba and Harriet soils are best suited to range. The main

concerns in managing cultivated areas are controlling water erosion on all the major soils and improving root penetration in the Rhoades soils. The main concerns in managing range and pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

Badland and Shallow and Deep, Loamy Soils Formed in Material Weathered from Bedrock, in Glacial Till, and in Alluvium

These soils are on dissected uplands and truncated till plains and moraines. They make up about 6 percent of the county. Most areas are used for range. They are best suited to this use. The main concerns in managing range are maintaining an adequate cover of the important range plants and achieving a uniform distribution of grazing.

9. Cabba-Zahl-Shambo Association

Shallow and deep, medium textured and moderately fine textured, moderately sloping to very steep, well drained soils

This association consists of moderately sloping to very steep soils on the upper and lower side slopes, summits, shoulder slopes, and foot slopes on dissected uplands and truncated till plains and moraines. Slope ranges from 6 to 70 percent.

This association makes up about 4 percent of the county. It is about 30 percent Cabba soils, 25 percent Zahl soils, 20 percent Shambo soils, and 25 percent soils of minor extent.

The shallow, moderately sloping to very steep Cabba soils are on the upper side slopes. Typically, they are light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock.

The deep, moderately steep to very steep Zahl soils are on summits and shoulder slopes. Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam.

The deep, moderately sloping and strongly sloping, well drained Shambo soils are on the lower side slopes and foot slopes. Typically, the surface layer is dark grayish brown clay loam about 5 inches thick. The subsoil is loam about 42 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is grayish brown loam.

Minor in this association are Arikara soils, Badland, and Cherry, Flasher, Harriet, Korchea, and Straw soils. The Arikara soils and the Badland are on side slopes. The Arikara soils are deep and have a clay loam subsoil. The Badland consists of barren, eroding bedrock. The Cherry soils have a thin surface layer of light brownish gray silty clay loam. They are on foot slopes. The Flasher soils are shallow and have a loamy sand surface layer. They are on knolls. The Harriet soils are poorly drained and have a dense, alkali subsoil. They are in drainageways. The Korchea and Straw soils are well drained. They are on terraces and flood plains.

Most areas are used for range. The soils are suited to this use. The Shambo soils are suited to cultivated crops. The main concerns in managing range are maintaining an adequate cover of the important range plants and achieving a uniform distribution of grazing. The main concern in managing cultivated areas is controlling water erosion. The minor Arikara soils support stands of trees and shrubs that provide habitat for wildlife and winter feeding areas for livestock.

10. Cabba-Badland Association

Badland and shallow, medium textured, moderately sloping to very steep, well drained soils

This association occurs as areas of Badland and moderately sloping to very steep soils on side slopes and summits on dissected uplands. Slope ranges from 6 to 70 percent.

This association makes up about 2 percent of the county. It is about 40 percent Cabba soils, 35 percent Badland, and 25 percent soils of minor extent (fig. 8).

The Cabba soils are on the upper side slopes and summits. Typically, they are light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock.

The Badland generally is on south-facing side slopes. Typically, it consists of eroding, soft, silty and clayey bedrock. It is barren of vegetation.

Cherry, Flasher, Williams, and Zahl are the principal minor soils in this association. The Cherry soils are deep and have a thin surface layer of light brownish gray silty clay loam. They are on foot slopes. The Flasher soils are shallow and have a loamy sand surface layer. They are on summits and side slopes. The Williams soils have a loam surface layer and a clay loam subsoil. They are on summits. The Zahl soils are calcareous throughout. They are on summits and shoulder slopes.

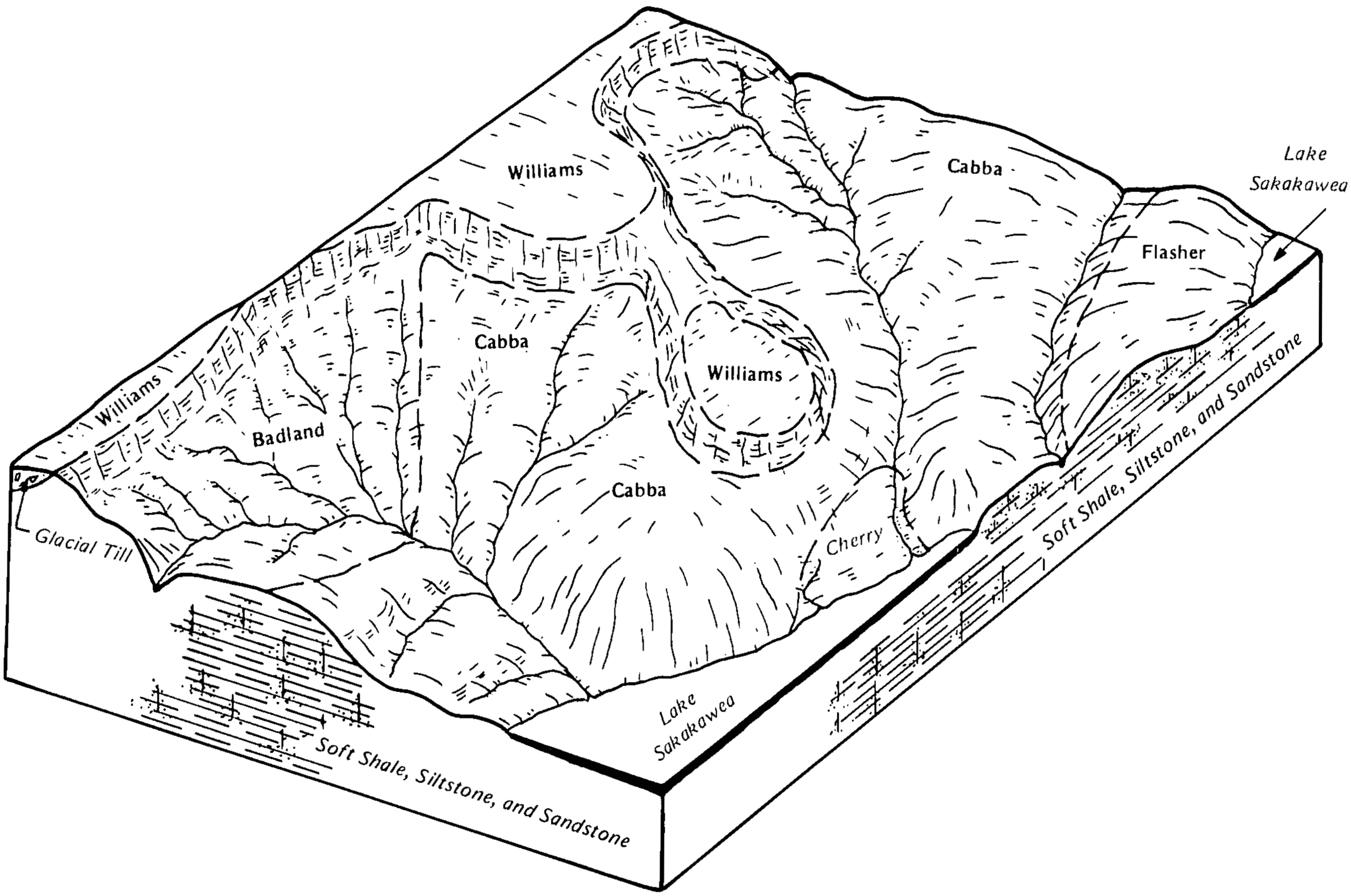


Figure 8.—Typical pattern of soils and parent material in the Cabba-Badland association.

Most areas are used for range or wildlife habitat. The soils are suited to these uses. The main concerns in managing range are maintaining an adequate cover of the important range plants and achieving a uniform distribution of grazing.

Deep, Loamy Soils Formed in Alluvium

These soils are on flood plains and terraces. They make up about 2 percent of the county. Most areas are used for range or cultivated crops, but some are used for pasture. The soils are well suited to range and pasture and are suited to cultivated crops. The Harriet soils are best suited to range. The main concern in managing cultivated areas is maintaining tilth and fertility. The main concern in managing range or pasture is maintaining an adequate cover of the important range or suitable pasture plants.

11. Straw-Shambo-Korchea Association

Deep, medium textured, level to gently sloping, well drained soils

This association consists of level to gently sloping soils on flats and rises and in swales on flood plains and terraces. Most areas are crossed by shallow, intermittent drainageways. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 45 percent Straw soils, 20 percent Shambo soils, 15 percent Korchea soils, and 20 percent soils of minor extent.

The level and nearly level Straw soils are on flats and in swales. Typically, the surface soil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The upper part of the

substratum is light brownish gray loam, the next part is grayish brown loam, and the lower part to a depth of about 60 inches is brown silt loam.

The nearly level and gently sloping Shambo soils are on flats and rises. Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is loam about 42 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is grayish brown loam.

The level and nearly level Korchea soils are on flats. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is grayish brown, stratified loam and silt loam; light brownish gray, stratified silt loam and loam; light brownish gray very fine sandy loam; light brownish gray loam; and light olive brown, mottled silty clay loam.

Harriet, Rhoades, and Savage are the principal minor soils in this association. The Harriet soils are poorly drained and have a dense, alkali subsoil. They are on flats and in swales. The Rhoades soils are moderately well drained and have a dense, alkali subsoil. They are on flats. The Savage soils have a silty clay surface layer and subsoil. They are intermingled with areas of the Shambo soils.

Most areas are used for cultivated crops, but some areas are used for range or pasture. The soils are suited to these uses. The main concerns in managing cultivated areas are maintaining tilth and fertility on the Korchea and Straw soils and controlling water erosion on the Shambo soils. The main concerns in managing range or pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

12. Harriet-Korchea Association

Deep, medium textured, level and nearly level, poorly drained and well drained soils

This association consists of level and nearly level soils on flats and in swales on flood plains and terraces. Most areas are crossed by shallow, intermittent drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 1 percent of the county. It is about 70 percent Harriet soils, 10 percent Korchea soils, and 20 percent soils of minor extent.

The level, poorly drained, alkali Harriet soils are on flats and in swales. Typically, the surface layer is gray loam about 1 inch thick. The subsoil is about 44 inches thick. It is grayish brown clay loam in the upper part; pale brown, mottled clay loam in the next part; and pale brown, mottled silty clay loam in the lower part. The substratum is light brownish gray to a depth of about 60 inches. It is stratified clay loam and sandy loam in the upper part and clay loam in the lower part.

The level and nearly level, well drained Korchea soils are on flats. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is grayish brown, stratified loam and silt loam; light brownish gray, stratified silt loam and loam; light brownish gray very fine sandy loam; light brownish gray loam; and light olive brown, mottled silty clay loam.

Shambo, Vallers, and Zahl are the principal minor soils in this association. The Shambo soils have a loam surface layer and subsoil. They are on rises and flats. The Vallers soils are poorly drained and highly calcareous. They are in channels and depressions. The Zahl soils have a subsoil that is calcareous throughout. They are on knolls and ridges.

Most areas are used for range, but some are used for cultivated crops or pasture. The soils are suited to these uses. The Harriet soils are best suited to range. The main concern in managing cultivated areas is maintaining tilth and fertility in the Korchea soils. The main concerns in managing range or pasture are maintaining an adequate cover of the important range or suitable pasture plants and achieving a uniform distribution of grazing.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Shambo loam, 1 to 6 percent slopes, is a phase of the Shambo series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Korchea and Straw loams, 0 to 3 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Badland is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries and soil names on the detailed soil map of Mountrail County do not match those on the maps of McLean and Ward Counties. The differences are a result of improvements in the classification of soils, particularly modifications or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey areas.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

2—Parnell silt loam. This deep, level, very poorly drained soil is in depressions on till plains, moraines, and lake plains. It is subject to ponding. Individual areas

range from about 3 to more than 20 acres in size.

Typically, the surface has a 1-inch cover of roots and partially decayed roots and leaves. The surface soil is about 11 inches thick. It is dark gray. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is dark gray clay about 19 inches thick. Below this to a depth of about 60 inches is gray clay. In places the soil has a subsurface layer.

Included with this soil in mapping are small areas of Hamerly, Miranda, and Vallers soils. These soils make up about 10 to 20 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats between the depressions. The Miranda and Vallers soils are on the rim of the depressions. The Miranda soils have a dense, alkali subsoil. The Vallers soils are poorly drained and highly calcareous.

Permeability is slow in the Parnell soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 2 feet above to 2 feet below the surface. Tilth is good.

Most areas are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas delays tillage and seeding in some years and prevents them in other years. The hazards of water erosion and soil blowing are slight. A system of conservation tillage that leaves crop residue on the surface helps to maintain tilth and fertility and control erosion. Conservation tillage also provides food and cover for wildlife.

This soil is well suited to wetland wildlife habitat. The soil and the ponded water provide an early season breeding site and a good source of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used for range, the important forage plants are slough sedge, rivergrass, and American mannagrass. If the soil is drained, creeping foxtail and reed canarygrass are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing during wet periods.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 25 to 73, depending on the degree of drainage. The range site is Wetland.

3—Tonka silt loam. This deep, level, poorly drained soil is in shallow depressions on till plains, moraines, and lake plains. It is subject to ponding. Individual areas range from about 3 to more than 10 acres in size.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The subsurface layer is gray, mottled silt loam about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 21 inches thick. The next layer is dark grayish brown, mottled clay loam about 7 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In places the soil is calcareous within a depth of 16 inches.

Included with this soil in mapping are small areas of Bowbells, Hamerly, and Parnell soils. These soils make up about 10 to 25 percent of the unit. The Bowbells soils are moderately well drained. They are in swales and on flats. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats and rises between the depressions. The Parnell soils are very poorly drained. They are in the deeper part of the depressions.

Permeability is slow in the Tonka soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 0.5 foot above to 1.0 foot below the surface. Tilth is good.

Most areas are used for cultivated crops, range, or wetland wildlife habitat. If drained, this soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas delays tillage and seeding in some years and prevents them in a few years. The hazards of water erosion and soil blowing are slight. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and maintain tilth and fertility. Conservation tillage also provides food and cover for wildlife.

This soil is well suited to wetland wildlife habitat. The soil and the ponded water provide an early season

breeding site and a good source of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used for range, the important forage plants are prairie cordgrass, wooly sedge, and slim sedge. Creeping foxtail and reed canarygrass are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing during wet periods.

If drained, this soil is suited to all climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings.

The land capability classification is IIw. The productivity index for spring wheat ranges from 46 to 85, depending on the degree of drainage. The range site is Wet Meadow.

4—Vallers loam, saline. This deep, level, poorly drained, moderately saline, highly calcareous soil is in drainageways on till plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is loam about 6 inches thick. It is dark gray in the upper part and grayish brown in the lower part. It has masses of salts. The subsoil is white loam about 22 inches thick. The upper part of the substratum is gray, mottled loam. The lower part to a depth of about 60 inches is light olive gray, mottled coarse sandy loam. In some places gravelly sand is at a depth of 30 to 40 inches. In other places the soil is only slightly saline. In a few areas the substratum is silty clay.

Included with this soil in mapping are small areas of the alkali Harriet soils on flood plains. These soils make up about 1 to 10 percent of the unit. Also included are some stream channels, oxbows, and escarpments.

Permeability is moderately slow in the Vallers soil. Runoff is slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot. Tilth is good. A high content of salts restricts plant growth.

Most areas are used for range. Because of the salinity, this soil is poorly suited to flax, safflower, small grain, and sunflowers. It is best suited to grasses and legumes for pasture and hay, to salt-tolerant crops, and to range. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are overcoming wetness and salinity and controlling soil blowing. Installing and maintaining a surface drainage system can reduce the wetness, but locating suitable drainage outlets is difficult. As a result, few areas are drained. The degree of salinity has increased in some drained areas. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity. When the bare soil surface dries, salt-laden water tends to move to the surface. As a result, summer fallow should be avoided.

In areas where this soil is used for range, the important forage plants are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, western wheatgrass, and alsike clover are suitable hay and pasture plants. The high content of salts, a reduced supply of available water, compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by maintaining an adequate cover of the important or suitable salt-tolerant forage plants and by deferring grazing during wet periods. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soil. When the bare soil surface dries, salt-laden water tends to move to the surface. Reducing the evaporation rate at the surface improves seedling survival. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 18 to 33, depending on the degrees of drainage and salinity. The range site is Saline Lowland.

5—Belfield silt loam, 1 to 3 percent slopes. This deep, nearly level, well drained, alkali soil is on flats on terraces and fans. Many areas are dissected by shallow

drainageways. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The next layer is grayish brown silty clay loam about 4 inches thick. The subsoil is silty clay about 22 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light yellowish brown silty clay loam. In places the soil does not have an alkali subsoil.

Included with this soil in mapping are small areas of Farnuf, Savage, and Shambo soils. These soils make up about 10 to 30 percent of the unit. Also included is a soil that has a dense, alkali subsoil. Farnuf, Savage, and Shambo soils do not have a subsurface layer or an alkali subsoil. They are intermingled with areas of the Belfield soil.

Permeability is slow in the Belfield soil. Runoff also is slow. Available water capacity is high. The alkali subsoil restricts the depth to which plant roots can penetrate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for wildlife. Applying a method of tillage that loosens the alkali subsoil or growing deep-rooted crops, such as alfalfa and sweetclover, improves root and water penetration. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and blue grama. Intermediate wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification is IIIs. The productivity index for spring wheat is 82. The range site is Clayey.

9B—Savage silty clay loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on flats on terraces and fans. Most areas are dissected by shallow drainageways. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 43 inches thick. In sequence downward, it is dark grayish brown silty clay, grayish brown silty clay, light brownish gray silty clay, and light brownish gray silty clay loam. The substratum to a depth of about 60 inches is light brownish gray clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil is silt loam.

Included with this soil in mapping are small areas of Belfield, Rhoades, and Shambo soils. These soils are intermingled with areas of the Savage soil. They make up about 5 to 15 percent of the unit. The Belfield soils have an alkali subsoil. The Rhoades soils have a dense, alkali subsoil. The Shambo soils have less clay in the subsoil and substratum than the Savage soil.

Permeability is slow in the Savage soil. Runoff is medium. Available water capacity is high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are controlling water erosion, maintaining or improving tilth, and maintaining fertility. A system of conservation tillage that leaves crop residue on the surface, stripcropping, diversions, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for wildlife. Deferring tillage when the soil is wet helps to prevent compaction, surface crusting, and the formation of hard clods that make a poor seedbed. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are green needlegrass, western wheatgrass, and blue grama. Green needlegrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed.

Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 80. The range site is Clayey.

10—Makoti silty clay loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flats on lake plains. Individual areas range from about 3 to more than 200 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. It is dark grayish brown silty clay loam in the upper part, grayish brown silty clay loam in the next part, and light brownish gray, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is light yellowish brown, mottled clay loam. In some places the lower part of the substratum is fine sand. In other places the surface layer and subsoil are loam.

Included with this soil in mapping are small areas of Nutley and Tonka soils. These soils make up about 5 to 20 percent of the unit. The Nutley soils have more clay in the surface layer and subsoil than the Makoti soil. They are intermingled with areas of the Makoti soil. The Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Makoti soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 5 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to maintain or improve tilth and provides food and cover for wildlife. Deferring tillage when the soil is wet helps to prevent compaction, surface crusting, and the formation of hard clods that make a poor seedbed. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for pasture or range.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical soil limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 92. The range site is Silty.

12—Bowdle loam, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on flats on outwash plains and terraces. Individual areas range from about 5 to more than 250 acres in size.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is loam about 19 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The upper part of the substratum is brown gravelly coarse sand. The lower part to a depth of about 60 inches is grayish brown very gravelly coarse sand. In some places the soil has a buried surface layer. In other places the dark color of the surface layer extends to a depth of only 7 to 16 inches. In some areas the lower part of the substratum is clay loam. In other areas the surface layer and subsoil are sandy loam.

Included with this soil in mapping are small areas of Divide, Lehr, and Wabek soils. These soils make up about 10 to 25 percent of the unit. The Divide soils are somewhat poorly drained and highly calcareous. They are in swales. The Lehr soils have sand and gravel at a depth of less than 20 inches. They are on rises. The Wabek soils have sand and gravel at a depth of less than 14 inches. They are on knolls and ridges.

Permeability is moderate in the upper part of the Bowdle soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The sand and gravel restrict the depth to which plant roots can penetrate. Tilth is good.

Most areas are used for cultivated crops, but some areas are used for pasture and hay. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture or hay. Rye and winter wheat are better suited than other crops because

they can make the best use of the moisture available early in the growing season. The hazards of soil blowing and water erosion are slight. The main concerns in managing cultivated areas are maintaining tilth and fertility and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also provides food and cover for wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation or supplemental watering helps to ensure the survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIs. The productivity index for spring wheat is 59. The range site is Silty.

14—Divide loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is in drainageways, on flats, and in swales on outwash plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is dark gray loam about 7 inches thick. The subsoil is about 27 inches thick. It is light brownish gray sandy clay loam in the upper part; grayish brown, mottled sandy clay loam in the next part; and white, mottled gravelly sand in the lower part. The upper part of the substratum is light yellowish brown sand. The lower part to a depth of about 60 inches is light gray, mottled loamy fine sand. In some places the soil is moderately saline. In other places the substratum is olive gray. In some areas the upper part of the substratum is loam or clay loam.

Included with this soil in mapping are small areas of Bowdle and Manning soils on rises. These soils make up about 10 to 25 percent of the unit. The Bowdle soils are well drained. The Manning soils are somewhat excessively drained. Also included are some areas of saline soils.

Permeability is moderate in the upper part of the Divide soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The sand and gravel restrict the depth to which plant roots can penetrate. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Tillage and seeding may be delayed because of wetness in some years, but crops are grown each year. The main concerns in managing cultivated areas are maintaining tilth and fertility and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are little bluestem, big bluestem, and switchgrass. Tall wheatgrass, big bluestem, slender wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 56. The range site is Limy Subirrigated.

15—Straw loam, channeled. This deep, level, well drained soil is on flats and in swales on flood plains. It is frequently flooded. Most areas are on broad bottom land, but some are in narrow valleys. The landscape is

characterized by meandering stream channels, oxbows, and escarpments. Individual areas range from about 25 to more than 150 acres in size.

Typically, the surface soil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The upper part of the substratum is light brownish gray loam. The next part is grayish brown loam. The lower part to a depth of about 60 inches is brown silt loam. In some places the dark color of the surface soil extends to a depth of only 5 to 16 inches. In other places the substratum is fine sandy loam. In some areas the surface layer and substratum are loamy sand.

Included with this soil in mapping are small areas of Harriet, Lehr, and Rhoades soils. These soils make up about 15 to 30 percent of the unit. The Harriet soils have a dense, alkali subsoil. They are poorly drained and are in oxbows. The Lehr soils have a substratum of sand and gravel. They are on rises. The Rhoades soils have a dense, alkali subsoil. They are intermingled with areas of the Straw soil. Also included are some steep escarpments and oxbows.

Permeability is moderate in the Straw soil. Runoff is slow. Available water capacity is high.

Most areas are used for range or wildlife habitat. A few areas are cultivated, but they are small and irregular in shape. Because of the steep-sided channels, which generally cannot be crossed by machinery, this soil generally is unsuited to cultivated crops and hay. It is best suited to range and wildlife habitat.

The important range plants are big bluestem, green needlegrass, and western wheatgrass. Big bluestem, smooth bromegrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Scouring during periods of flooding is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to prevent scouring.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Overflow.

17—Hamerly-Tonka complex, 0 to 3 percent slopes. These deep soils are on till plains. The level and nearly level, somewhat poorly drained Hamerly soil is on flats surrounding depressions. The level, poorly drained Tonka soil is in shallow depressions. It is subject to ponding. Individual areas range from about 5 to more than 30 acres in size. They are about 40 to 50 percent Hamerly soil and 35 to 45 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of dark gray loam about 8 inches thick. The subsoil is calcareous, very pale brown, mottled loam about 26 inches thick. The substratum to a depth of about 60 inches is light yellowish brown loam. In some places depth to the calcareous subsoil is as much as 20 inches. In other places the soil is moderately saline.

Typically, the Tonka soil has a surface layer of dark gray silt loam about 8 inches thick. The subsurface layer is gray, mottled silt loam about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 28 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In places the soil is calcareous within a depth of 16 inches.

Included with these soils in mapping are small areas of Bowbells, Miranda, Parnell, and Williams soils. These included soils make up about 10 to 20 percent of the unit. The Bowbells and Miranda soils are on rises. They are moderately well drained. The Parnell soils are very poorly drained. They are in the deeper part of the depressions. The Williams soils are well drained. They are on rises.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Tilth is good in both soils.

Most areas are used for cultivated crops. The Hamerly soil and drained areas of the Tonka soil are well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. In undrained areas of the Tonka soil, wetness delays tillage and seeding in some years and prevents them in a few years. Locating suitable drainage outlets is difficult. As a result, few areas are drained. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing on the Hamerly soil. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow

layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

The Tonka soil is well suited to wetland wildlife habitat, but the Hamerly soil is poorly suited. The Tonka soil and the ponded water provide an early season breeding site and a good source of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where these soils are used for range, the important forage plants are big bluestem, little bluestem, and switchgrass on the Hamerly soil and prairie cordgrass, slim sedge, and wooly sedge on the Tonka soil. Slender wheatgrass, creeping foxtail, reed canarygrass, and sweetclover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the Tonka soil is wet. They can be overcome by deferring grazing during wet periods. Soil blowing is a hazard on the Hamerly soil, especially if the range is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

The Hamerly soil and drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil generally are unsuited to these uses. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat ranges from 66 to 82, depending on the degree of drainage in areas of the Tonka soil. The range site of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet Meadow.

18B—Shambo loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on flats on terraces and fans. Most areas are dissected by shallow drainageways. Individual areas range from about 10 to more than 300 acres in size.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is loam about 42 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light brownish gray and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown loam. In some places the subsoil has an accumulation of clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the subsoil and substratum are silt loam. In other areas soft bedrock is at a depth of 20 to 40 inches. In a few areas the noncalcareous subsoil is only 3 to 5 inches thick.

Included with this soil in mapping are small areas of Bowdle, Lehr, and Savage soils. These soils make up about 5 to 15 percent of the unit. The Bowdle and Lehr soils have a sand and gravel substratum. They are intermingled with areas of the Shambo soil. The Savage soils have a silty clay subsoil. They are in swales.

Permeability is moderate in the Shambo soil. Runoff is medium. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are controlling water erosion and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 82. The range site is Silty.

18C—Shambo loam, 6 to 9 percent slopes. This deep, moderately sloping, well drained soil is on side slopes on terraces and fans. Many areas are dissected

by shallow drainageways. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is loam about 42 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is grayish brown loam. In some places the subsoil has an accumulation of clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the subsoil and substratum are silt loam. In other areas soft bedrock is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Cabba, Cherry, Rhoades, and Savage soils. These soils make up about 5 to 20 percent of the unit. The Cabba soils are shallow. They are on knobs. The Cherry soils have a thin surface layer of light colored silty clay loam. They are on rises. The Rhoades and Savage soils are in swales. The Rhoades soils have a dense, alkali subsoil. The Savage soils have a silty clay subsoil.

Permeability is moderate in the Shambo soil. Runoff is rapid. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture or hay. The hazard of soil blowing is slight, and the hazard of water erosion is severe. The main concerns in managing cultivated areas are controlling water erosion and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to maintain tilth and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 60. The range site is Silty.

19—Nutley silty clay, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on flats on lake plains. Individual areas range from about 5 to more than 200 acres in size.

Typically, the surface layer is dark gray silty clay about 5 inches thick. The subsoil is grayish brown silty clay about 21 inches thick. The next layer is grayish brown silty clay about 10 inches thick. The substratum to a depth of about 60 inches is light olive gray clay. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil has an accumulation of clay.

Included with this soil in mapping are small areas of Farnuf, Makoti, Sakakawea, and Tonka soils. These soils make up about 5 to 15 percent of the unit. The Farnuf and Makoti soils are intermingled with areas of the Nutley soil. The Farnuf soils have a loam surface layer and subsoil. The Makoti soils are moderately well drained and have a silty clay loam surface layer and subsoil. The Sakakawea soils have a silt loam subsoil. They are on knolls and ridges. The Tonka soils are poorly drained. They are in shallow depressions.

Permeability is slow in the Nutley soil. Runoff also is slow. Available water capacity is moderate. Tilth is poor.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing, improving tilth, and maintaining fertility. A system of conservation tillage that leaves crop residue on the surface, buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to improve tilth and provides food and cover for wildlife. Deferring tillage when the soil is wet helps to prevent compaction, surface crusting, and the formation of hard clods that make a poor seedbed. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are green needlegrass, blue grama, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil

blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIs. The productivity index for spring wheat is 86. The range site is Clayey.

19B—Nutley silty clay, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on side slopes on lake plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is very dark gray silty clay about 5 inches thick. The subsoil is grayish brown silty clay about 21 inches thick. The next layer is grayish brown silty clay about 10 inches thick. The substratum to a depth of about 60 inches is light olive gray silty clay. In places the subsoil has an accumulation of clay.

Included with this soil in mapping are small areas of Farnuf, Sakakawea, and Tonka soils. These soils make up about 1 to 10 percent of the unit. The Farnuf soils have a loam surface layer and subsoil. They are intermingled with areas of the Nutley soil. The Sakakawea soils have a silt loam subsoil. They are on knolls and ridges. The Tonka soils are poorly drained. They are in depressions.

Permeability is slow in the Nutley soil. Runoff is medium. Available water capacity is moderate. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are moderate. The main concerns in managing cultivated areas are controlling soil blowing and water erosion, improving tilth, and maintaining fertility. A system of conservation tillage that leaves crop residue on the surface, buffer strips, field windbreaks, stripcropping, diversions, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to improve tilth and provides food and cover for wildlife. Deferring tillage when the soil is wet helps to prevent compaction, surface crusting, and the formation of hard clods that make a poor seedbed. Additions of organic material to the plow layer improve fertility, maintain or improve tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are green needlegrass, blue grama, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 73. The range site is Clayey.

23—Williams loam, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on flats on till plains. Individual areas range from about 5 to more than 300 acres in size.

Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the surface layer is clay loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the noncalcareous part of the subsoil is only 3 to 5 inches thick.

Included with this soil in mapping are small areas of Hamerly, Noonan, Tonka, and Zahl soils. These soils make up about 10 to 20 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Noonan soils have a dense, alkali subsoil. They are intermingled with areas of the Williams soil. The Tonka soils are poorly drained. They are in shallow depressions. The Zahl soils have a subsoil that is calcareous throughout. They are on knolls.

Figure 9.—An area of Williams loam, 1 to 3 percent slopes, where a system of conservation tillage that leaves crop residue on the surface helps to control water erosion.

Permeability is moderately slow in the Williams soil. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture or hay. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface helps to control erosion (fig. 9). Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 82. The range site is Silty.

23B—Williams-Zahl loams, 3 to 6 percent slopes. These deep, undulating, well drained soils are on till plains. The Williams soil is on side slopes and summits. The Zahl soil is on knolls, ridges, and shoulder slopes. Individual areas range from about 5 to more than 600 acres in size. They are about 65 to 80 percent Williams soil and 15 to 30 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the subsoil does not have an accumulation of clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In a few areas the noncalcareous part of the subsoil is only 3 to 5 inches thick.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam.

Included with these soils in mapping are small areas of Hamerly, Noonan, Parnell, Tonka, and Wabek soils. These included soils make up about 1 to 10 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Noonan soils have a dense, alkali subsoil. They are intermingled with areas of the Williams soil. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained. The Wabek soils have a sand and gravel substratum. They are on knolls.

Permeability is moderately slow in the Williams and Zahl soils. Runoff is medium. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing on the Zahl soil is moderate, and that on the Williams soil is slight. The hazard of water erosion is moderate on both soils. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, stripcropping, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, green needlegrass, needleandthread, and little bluestem. Intermediate wheatgrass, crested wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Williams soil is IIe, and that of the Zahl soil is IIIe. The productivity index of the unit for spring wheat is 71. The range site of the Williams soil is Silty, and that of the Zahl soil is Thin Upland.

24C—Williams-Zahl loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on till plains. The Williams soil is on side slopes and summits. The Zahl soil is on shoulder slopes and knolls. Individual areas range from about 5 to more than 250 acres in size. They are about 50 to 65 percent Williams soil and 30 to 45 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and

calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the subsoil does not have an accumulation of clay. In other places the noncalcareous part of the subsoil is only 3 to 5 inches thick. In a few areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Included with these soils in mapping are small areas of Hamerly, Lehr, Miranda, Parnell, and Tonka soils. These included soils make up about 1 to 10 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Lehr soils have a sand and gravel substratum. They are on knolls and flats. The Miranda soils have a dense, alkali subsoil. They are in swales. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained. Also included are small areas of very stony soils.

Permeability is moderately slow in the Williams and Zahl soils. Runoff is rapid. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing on the Zahl soil is moderate, and that on the Williams soil is slight. The hazard of water erosion is severe on both soils. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion and soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, green needlegrass, needleandthread, and little bluestem. Intermediate wheatgrass, crested wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion and soil blowing. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Williams soil is IIIe, and that of the Zahl soil is IVe. The productivity index of the unit for spring wheat is 50. The range site of the Williams soil is Silty, and that of the Zahl soil is Thin Upland.

24E—Zahl-Williams loams, 9 to 25 percent slopes. These deep, rolling and hilly, well drained soils are on moraines. The Zahl soil is on shoulder slopes and knolls. The Williams soil is on side slopes and summits. Individual areas range from about 5 to more than 500 acres in size. They are about 40 to 60 percent Zahl soil and 30 to 50 percent Williams soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the surface layer is clay loam. In other places the subsoil does not have an accumulation of clay. In some areas the noncalcareous part of the subsoil is only 3 to 5 inches thick. In a few areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas

of Hamerly, Noonan, Parnell, Southam, Tonka, and Wabek soils. These included soils make up about 5 to 15 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Noonan soils have a dense, alkali subsoil. They are in swales. The Parnell and Southam soils are in deep depressions. They are very poorly drained. The Tonka soils are poorly drained. They are in shallow depressions. The Wabek soils have a sand and gravel substratum. They are on knolls and ridges. Also included are some very stony areas.

Permeability is moderately slow in the Williams and Zahl soils. Runoff is very rapid. Available water capacity is high.

Most areas are used for range, but a few areas are used for cultivated crops. Because of the slope, a moderate hazard of soil blowing on the Zahl soil, and a very severe hazard of water erosion on both soils, these soils generally are unsuited to cultivated crops. They are best suited to range, hay, and pasture. Returning the cultivated areas to a permanent cover of grass helps to control soil blowing and water erosion.

The important range plants are western wheatgrass, needleandthread, and little bluestem. Intermediate wheatgrass, crested wheatgrass, smooth bromegrass, sweetclover, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Zahl soil is VIIe, and that of the Williams soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Williams soil is Silty.

24F—Zahl-Max loams, 25 to 60 percent slopes. These deep, well drained soils are on moraines and truncated till plains. The steep and very steep Zahl soil is on shoulder slopes and knolls. The steep Max soil is on side slopes. Individual areas range from about 10 to more than 200 acres in size. They are about 55 to 65 percent Zahl soil and 20 to 30 percent Max soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Typically, the Max soil has a surface layer of very dark grayish brown loam about 7 inches thick. The subsoil is clay loam about 31 inches thick. It is dark grayish brown in the upper part, brown in the next part, and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is light yellowish brown clay loam. In some places the subsoil has an accumulation of clay. In other places the noncalcareous part of the subsoil is only 3 to 5 inches thick.

Included with these soils in mapping are small areas of Bowbells, Harriet, Lehr, and Wabek soils. These included soils make up about 10 to 20 percent of the unit. In the Bowbells soils the dark color of the surface layer extends to a depth of more than l6 inches. These soils are on foot slopes. The Harriet soils are poorly drained and have a dense, alkali subsoil. They are in drainageways. The Lehr and Wabek soils have a sand and gravel substratum. They are on knolls. Also included are some stony areas.

Permeability is moderately slow in the Max and Zahl soils. Runoff is very rapid. Available water capacity is high.

Most areas are used for range (fig. 10), but a few areas are used for cultivated crops. Because of the slope, a moderate hazard of soil blowing on the Zahl soil, and a very severe hazard of water erosion on both soils, these soils generally are unsuited to cultivated crops. They are best suited to range, hay, and pasture. Returning the cultivated areas to a permanent cover of grass helps to control erosion. Reestablishing vegetation is difficult in cultivated and denuded areas. The slope limits the use of machinery.

The important range plants are western wheatgrass, needleandthread, and little bluestem. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important forage plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be

Figure 10.—An area of Zahl-Max loams, 25 to 60 percent slopes, used for range.

grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Zahl and Max soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Max soil is Silty.

25C—Zahl-Williams-Bowbells loams, 3 to 9 percent slopes. These deep soils are on moraines. The gently rolling, well drained Zahl soil is on shoulder slopes and knolls. The gently rolling, well drained Williams soil is on side slopes. The gently sloping, moderately well drained Bowbells soil is on foot slopes and in swales. Individual areas range from about 5 to more than 250 acres in size. They are about 45 to 60 percent Zahl soil, 25 to 35 percent Williams soil, and 10 to 20 percent Bowbells soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the surface layer is clay loam. In other places the subsoil does not have an accumulation of clay. In some areas the noncalcareous part of the subsoil is only 3 to 5 inches thick.

Typically, the surface layer of the Bowbells soil is loam about 7 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The

subsoil to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part, brown and calcareous in the next part, and light gray and calcareous in the lower part. In some places the subsoil does not have an accumulation of clay. In other places the lower part of the subsoil does not have an accumulation of lime.

Included with these soils in mapping are small areas of Hamerly, Livona, Parnell, Tonka, and Wabek soils. These included soils make up about 1 to 10 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Livona soils are sandy loam in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Williams soil. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained. The Wabek soils have a gravelly substratum. They are on knolls. Also included are some cobbly and stony areas.

Permeability is moderately slow in the Zahl, Williams, and Bowbells soils. Runoff is rapid on the Zahl and Williams soils and medium on the Bowbells soil. Available water capacity is high in all three soils. Tilth is good.

Most areas are used for cultivated crops, but some areas are used for range. These soils are poorly suited to flax, safflower, small grain, and sunflowers and are suited to grasses and legumes for pasture and hay. The hazard of soil blowing on the Zahl soil is moderate, and that on the Williams and Bowbells soils is slight. The hazard of water erosion on the Zahl and Williams soils is severe, and that on the Bowbells soil is moderate. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion and soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, needleandthread, and little bluestem. Intermediate wheatgrass, crested wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Williams soil is suited to nearly all and the Bowbells soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Zahl soil is IVe, that of the Williams soil is IIIe, and that of the Bowbells soil is IIe. The productivity index of the unit for spring wheat is 48. The range site of the Zahl soil is Thin Upland, and that of the Williams and Bowbells soils is Silty.

27—Korchea and Straw loams, 0 to 3 percent slopes. These deep, level and nearly level, well drained soils are on flood plains and low terraces. They are occasionally flooded. The Korchea soil is on flats. The Straw soil is in swales and on flats. Individual areas range from about 5 to more than 100 acres in size. Any one area can consist of all Korchea soil, all Straw soil, or any combination of both soils.

Typically, the Korchea soil has a surface layer of dark grayish brown loam about 6 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is grayish brown, stratified loam and silt loam; light brownish gray, stratified silt loam and loam; light brownish gray very fine sandy loam; light brownish gray loam; and light olive brown, mottled silty clay loam. In some places the upper part of the substratum is not stratified. In other places the substratum is fine sandy loam.

Typically, the surface soil of the Straw soil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The upper part of the substratum is light brownish gray loam, the next part is grayish brown loam, and the lower part to a depth of about 60 inches is brown silt loam.

Included with these soils in mapping are small areas of Rhoades and Savage soils in swales. These included soils make up about 1 to 10 percent of the unit. The

Figure 11.—An area of Korchea and Straw loams, 0 to 3 percent slopes. These soils are well suited to hay and pasture.

Rhoades soils have a dense, alkali subsoil. The Savage soils have a silty clay subsoil.

Permeability is moderate in the Korchea and Straw soils. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops or hay. These soils are well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay (fig. 11). The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of these soils for range or pasture.

These soils are suited to all of the climatically

adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical soil limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Korchea and Straw soils is IIc. The productivity index of the unit for spring wheat is 89. The range site of both soils is Overflow.

32—Bowbells loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is in swales on till plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is loam about 7 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The subsoil to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part, brown and calcareous in the next part, and light gray and calcareous in the lower part. In some places the subsoil does not have an accumulation of clay. In other places the dark color of the surface layer extends to a depth of only 7 to 16 inches. In some areas the lower part of the subsoil does not have an accumulation of lime.

Included with this soil in mapping are small areas of Bowdle, Divide, Hamerly, Noonan, Tonka, and Zahl soils. These soils make up about 5 to 15 percent of the unit. The Bowdle soils have a sand and gravel substratum. They are in drainageways. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Noonan and Zahl soils are intermingled with areas of the Bowbells soil. The Noonan soils have a dense, alkali subsoil. The Zahl soils have a subsoil that is calcareous throughout. The Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Bowbells soil. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are green needlegrass, western wheatgrass, and big bluestem. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical soil limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 94. The range site is Overflow.

35—Bowbells-Tonka complex, 0 to 3 percent slopes. These deep soils are on till plains. The nearly level, moderately well drained Bowbells soil is in swales and on flats. The level, poorly drained Tonka soil is in shallow depressions. It is subject to ponding. Individual areas range from about 5 to more than 60 acres in size. They are about 45 to 65 percent Bowbells soil and 25 to 45 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Bowbells soil is loam about 7 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The subsoil to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part, brown and calcareous in the next part, and light gray and calcareous in the lower part. In some places the dark color of the surface layer extends to a depth of only 7 to 16 inches. In other places the subsoil is silty clay loam. In some areas the lower part of the subsoil is mottled. In other areas it does not have an accumulation of lime.

Typically, the Tonka soil has a dark gray silt loam surface layer about 8 inches thick. The subsurface layer is gray, mottled silt loam about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 21 inches thick. The next layer is dark grayish brown, mottled clay loam about 7 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In places the soil is calcareous within a depth of 16 inches.

Included with these soils in mapping are small areas

of Hamerly, Parnell, and Zahl soils. These included soils make up about 5 to 20 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Parnell soils are very poorly drained. They are in deep depressions. The Zahl soils have a subsoil that is calcareous throughout. They are on knolls.

Permeability is moderately slow in the Bowbells soil and slow in the Tonka soil. Runoff is slow on the Bowbells soil and ponded on the Tonka soil. Available water capacity is high in both soils. A seasonal high water table is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Tilth is good in both soils.

Most areas are used for cultivated crops. The Bowbells soil is well suited and drained areas of the Tonka soil are suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. In undrained areas of the Tonka soil, wetness delays tillage and seeding in some years and prevents them in a few years. Locating suitable drainage outlets is difficult. As a result, few areas are drained. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are green needlegrass, western wheatgrass, and big bluestem on the Bowbells soil and prairie cordgrass, slim sedge, and wooly sedge on the Tonka soil. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants on the Bowbells soil. Creeping foxtail and reed canarygrass are suitable plants on the Tonka soil. Compaction, trampling, and root shearing are problems on the Tonka soil, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing during wet periods. No major problems affect the use of the Bowbells soil for pasture or range.

The Bowbells soil and drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Bowbells soil is IIc, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat ranges from 72 to 88, depending on the degree of drainage in areas of the Tonka soil. The range site of the Bowbells soil is Overflow, and that of the Tonka soil is Wet Meadow.

39—Farnuf loam, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on flats on lake plains. Individual areas range from about 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 36 inches thick. In sequence downward, it is brown loam; yellowish brown loam; light yellowish brown, mottled loam; pale yellow, mottled clay loam; and pale yellow, mottled silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. The upper part is stratified pale yellow and light gray and is mottled, and the lower part is stratified light gray and reddish yellow. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Hamerly, Nutley, Parshall, Sakakawea, and Tonka soils. These soils make up about 5 to 15 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Nutley soils have a silty clay surface layer and subsoil. They are intermingled with areas of the Farnuf soil. The Parshall soils have a sandy loam surface layer and subsoil. They are on ridges. The Sakakawea soils have a subsoil that is calcareous throughout. They are on knolls and ridges. The Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderate in the Farnuf soil. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. The main concern in managing cultivated areas is maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the

important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 85. The range site is Silty.

39B—Farnuf-Sakakawea loams, 3 to 6 percent slopes. These deep, gently sloping, well drained soils are on lake plains. The Farnuf soil is on rises. The Sakakawea soil is on knolls and rims. Individual areas range from about 5 to more than 20 acres in size. They are about 65 to 80 percent Farnuf soil and 15 to 25 percent Sakakawea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Farnuf soil has a surface layer of very dark grayish brown loam about 5 inches thick. The subsoil is about 36 inches thick. In sequence downward, it is brown loam; yellowish brown loam; light yellowish brown, mottled loam; pale yellow, mottled clay loam; and pale yellow, mottled silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. The upper part is stratified pale yellow and light gray and is mottled, and the lower part is stratified light gray and reddish yellow. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil does not have an accumulation of clay.

Typically, the Sakakawea soil has a surface layer of grayish brown loam about 6 inches thick. The subsoil is calcareous silt loam about 15 inches thick. It is very pale brown in the upper part and light yellowish brown in the lower part. The upper part of the substratum is stratified light brownish gray and light yellowish brown, mottled silt loam; the next part is stratified light brownish gray and pale yellow, mottled loam; and the lower part to a depth of about 60 inches is stratified light brownish gray, mottled silty clay loam and pale yellow, mottled loamy sand. In places the substratum is clay loam.

Included with these soils in mapping are small areas of Makoti, Noonan, Nutley, and Williams soils. These included soils make up about 5 to 15 percent of the unit. The Makoti and Nutley soils are on flats. The Makoti soils have a silty clay loam subsoil and substratum. The Nutley soils have a silty clay surface layer and subsoil. The Noonan soils have a dense, alkali subsoil. They are in swales. The Williams soils have a clay loam substratum. They are on flats.

Permeability is moderate in the Farnuf and Sakakawea soils. Runoff is medium. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing on the Sakakawea soil is moderate, and that on the Farnuf soil is slight. The hazard of water erosion is moderate on both soils. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, green needlegrass, needleandthread, and little bluestem. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion.

The Farnuf soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Sakakawea soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Farnuf soil is IIe, and that of the Sakakawea soil is IIIe. The

productivity index of the unit for spring wheat is 72. The range site of the Farnuf soil is Silty, and that of the Sakakawea soil is Thin Upland.

41—Hamerly and Divide loams, saline. These deep, level, somewhat poorly drained, moderately saline, highly calcareous soils are in drainageways and swales and on flats on till plains and outwash plains. Individual areas range from about 5 to more than 100 acres in size. Any one area can consist of all Hamerly soil, all Divide soil, or any combination of both soils.

Typically, the Hamerly soil has a surface layer of dark gray loam about 8 inches thick. It has masses of salts. The subsoil is very pale brown, mottled loam about 26 inches thick. The substratum to a depth of about 60 inches is light yellowish brown loam. In places it is olive gray.

Typically, the Divide soil has a surface layer of dark gray loam about 7 inches thick. It has masses of salts. The subsoil is about 27 inches thick. It is light brownish gray sandy clay loam in the upper part; grayish brown, mottled sandy clay loam in the next part; and white gravelly sand in the lower part. The upper part of the substratum is light yellowish brown sand. The lower part to a depth of about 60 inches is light gray loamy fine sand. In some places the subsoil is olive gray. In other places depth to the calcareous subsoil is more than 16 inches.

Included with these soils in mapping are small areas of Bowbells, Bowdle, Tonka, and Williams soils. These included soils make up about 5 to 20 percent of the unit. They do not have an accumulation of lime within a depth of 16 inches. The Bowbells soils are moderately well drained. They are on flats. The Bowdle and Williams soils are well drained. They are on rises. The Tonka soils are poorly drained. They are in depressions. Also included are small areas of strongly saline soils.

Permeability is moderately slow in the Hamerly soil. It is moderate in the upper part of the Divide soil and rapid in the lower part. Runoff is slow on both soils. Available water capacity is moderate in the Hamerly soil and low in the Divide soil. A seasonal high water table is at a depth of 2 to 4 feet in both soils. Tilth is good. A high content of salts restricts plant growth.

Most areas are used for cultivated crops, but some areas are used for hay. These soils are poorly suited to flax, safflower, small grain, and sunflowers. They are best suited to grasses and legumes for pasture and hay, to range, and to salt-tolerant crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling salinity and soil blowing. Avoiding fallow and growing deep-rooted crops help to control salinity. Annual cropping helps to keep excess soil water from moving to the surface. Leaving crop residue on the surface helps to keep the surface from drying and thus allowing rainfall to leach the salts below the root zone. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, western wheatgrass, and alsike clover are suitable hay and pasture plants. The high content of salts, a reduced supply of available water, compaction, trampling, and root shearing are problems, especially if the range is grazed during wet periods. They can be overcome by maintaining an adequate cover of the important or suitable salt-tolerant forage plants and by deferring grazing during wet periods. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only a few of the most salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soils. When the bare soil surface dries, salt-laden water tends to move to the surface. Reducing the evaporation rate at the surface improves seedling survival. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly and Divide soils is IIIs. The productivity index of the unit for spring wheat is 35. The range site of both soils is Saline Lowland.

44B—Lihen loamy sand, loamy substratum, 1 to 6 percent slopes. This deep, nearly level and undulating, well drained soil is on ridges and flats on mantled till plains and lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface soil is loamy sand about 20 inches thick. It is brown in the upper part and very dark grayish brown in the lower part. The next layer is brown sand about 10 inches thick. The upper part of the

substratum is light brownish gray sand, the next part is light yellowish brown fine sand, and the lower part to a depth of about 60 inches is light yellowish brown clay loam. In some places the dark color of the surface layer extends to a depth of only 8 to 12 inches. In other places the substratum is sand to a depth of 60 inches. In some areas it is clay loam.

Included with this soil in mapping are small areas of Livona, Parshall, and Wabek soils. These soils are intermingled with areas of the Lihen soil. They make up about 1 to 10 percent of the unit. The Livona soils have a sandy loam surface layer and a clay loam substratum. The Parshall soils have a sandy loam surface layer and subsoil. The Wabek soils have a sand and gravel substratum.

Permeability is rapid in the upper part of the Lihen soil and moderately slow in the lower part. Runoff is slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is poorly suited to flax, safflower, small grain, and sunflowers. It is well suited to grasses and legumes for pasture and hay and to range. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are maintaining tilth and fertility and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, buffer strips, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are prairie sandreed, sand bluestem, and needleandthread. Sand bluestem, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and thus improves plant vigor and growth. It also helps to control soil blowing. Blowouts can occur along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent blowouts.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation or supplemental watering helps to ensure survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity of the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 46. The range site is Sands.

45B—Parshall sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on flats and in swales on outwash plains and lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsoil is sandy loam about 27 inches thick. It is dark grayish brown in the upper part and pale brown in the lower part. The upper part of the substratum is light yellowish brown loamy sand. The lower part to a depth of about 60 inches is stratified olive yellow and light yellowish brown loamy sand, sandy loam, and loam. In some places the dark color of the surface layer extends to a depth of only 7 to 15 inches. In other places the soil contains more clay and less sand.

Included with this soil in mapping are small areas of Lihen, Livona, and Wabek soils. These soils make up about 5 to 25 percent of the unit. The Lihen soils have a loamy sand surface layer and substratum. They are on knolls. The Livona soils are loam or clay loam in the lower part of the subsoil. They are on ridges. The Wabek soils have a sand and gravel substratum. They are on knolls and ridges.

Permeability is moderately rapid in the Parshall soil. Runoff is slow. Available water capacity is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are controlling soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, buffer strips, and stripcropping help to control soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the

rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are needleandthread, prairie sandreed, and western wheatgrass. Green needlegrass, western wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant vigor and growth. It also helps to control soil blowing. Denuding can occur along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 66. The range site is Sandy.

47B—Lehr loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat excessively drained soil is on flats and rises on outwash plains and terraces. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is about 16 inches thick. It is dark grayish brown loam in the upper part, pale brown loam in the next part, and light yellowish brown and white gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is light brownish gray and pale yellow very gravelly coarse sand. In some places the substratum is clay loam or silty clay loam at a depth of 40 to 60 inches. In other places the subsoil has an accumulation of clay.

Included with this soil in mapping are small areas of Bowdle, Divide, Wabek, Williams, and Zahl soils. These soils make up about 15 to 25 percent of the unit. The Bowdle soils are well drained. They are intermingled with areas of the Lehr soil. The Divide soils are somewhat poorly drained and highly calcareous. They are in swales. The Wabek soils are excessively drained. They are on knolls and ridges. The Williams and Zahl soils have a clay loam substratum. They are on rises.

Permeability is moderately rapid in the upper part of the Lehr soil and very rapid in the lower part. Runoff is medium. Available water capacity is low. The sand and gravel restrict the depth to which plant roots can penetrate. Tilth is good.

Most areas are used for cultivated crops, but some areas are used for hay. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for hay and pasture. Rye and winter wheat are better suited than other crops because they can make the best use of the moisture available early in the growing season. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are overcoming droughtiness and controlling water erosion. Leaving tall stubble on the surface helps to trap snow and thus increases the moisture supply. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage also provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are needleandthread, blue grama, and western wheatgrass. Intermediate wheatgrass, western wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion and droughtiness are problems, especially if the range is overgrazed. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant vigor and growth. It also helps to control water erosion.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation or supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 45. The range site is Shallow to Gravel.

49B—Manning sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat

excessively drained soil is on flats and rises on outwash plains and terraces. Individual areas range from about 5 to more than 200 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 7 inches thick. The subsoil is sandy loam about 16 inches thick. It is dark grayish brown in the upper part, brown in the next part, and very pale brown and pale brown in the lower part. The substratum to a depth of about 60 inches is light yellowish brown very gravelly sand. In some places it is sandy loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Bowdle, Parshall, Shambo, and Wabek soils. These soils make up about 5 to 15 percent of the unit. The Bowdle, Parshall, and Shambo soils are intermingled with areas of the Manning soil. The Bowdle soils have a loam surface layer and subsoil. The Parshall soils have a sandy loam surface layer and subsoil. The Shambo soils are loam throughout. The Wabek soils have sand and gravel within a depth of about 12 inches. They are on knolls and ridges.

Permeability is moderately rapid in the upper part of the Manning soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. The sand and gravel restrict the depth to which plant roots can penetrate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for hay and pasture. Rye and winter wheat are better suited than other crops because they can make the best use of the moisture available early in the growing season. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. Leaving tall stubble on the surface helps to trap snow and thus increases the moisture supply. A system of conservation tillage that leaves crop residue on the surface, windbreaks, grass barriers, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for wildlife.

In areas where this soil is used for range, the important forage plants are needleandthread and prairie sandreed. Green needlegrass, sand bluestem, western wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant vigor and growth. It also helps to control soil blowing. Denuding can occur along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation or supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 42. The range site is Sandy.

50C—Sakakawea loam, 3 to 9 percent slopes. This deep, gently sloping and moderately sloping, well drained soil is on knolls and rims of lake plains. Individual areas range from about 10 to more than 50 acres in size.

Typically, the surface layer is grayish brown loam about 6 inches thick. The subsoil is calcareous silt loam about 15 inches thick. It is very pale brown in the upper part and light yellowish brown in the lower part. The upper part of the substratum is stratified light brownish gray and light yellowish brown, mottled silt loam. The next part is stratified light brownish gray and pale yellow, mottled loam. The lower part to a depth of about 60 inches is stratified light brownish gray, mottled silty clay loam and pale yellow, mottled loamy sand. In places the substratum is clay loam.

Included with this soil in mapping are small areas of Farnuf, Lehr, Makoti, Manning, Nutley, and Parshall soils. These soils make up about 10 to 25 percent of the unit. The Farnuf, Makoti, and Nutley soils are on flats. The Farnuf and Makoti soils have a subsoil that is noncalcareous in the upper part. The Nutley soils have a silty clay surface layer and subsoil. The Lehr and Manning soils have a sand and gravel substratum. They are on rises. The Parshall soils have a sandy loam surface layer and subsoil. They are in swales.

Permeability is moderate in the Sakakawea soil. Runoff is rapid. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is poorly suited to flax, safflower, small grain, and

sunflowers and suited to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are moderate. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion and soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are little bluestem, western wheatgrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited only to the most drought-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 45. The range site is Thin Upland.

51B—Livona sandy loam, 1 to 6 percent slopes. This deep, nearly level and undulating, well drained soil is on flats and ridges on mantled till plains and lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsoil is about 30 inches thick. In sequence downward, it is brown sandy loam; brown sandy clay loam; grayish brown, mottled clay loam; light olive brown, mottled clay loam; and light brownish gray clay loam. The substratum to a depth of about 60 inches is light brownish gray clay loam. In some places the surface layer and the upper part of the subsoil are loamy sand. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the substratum is sandy loam. In a few areas the subsoil does not have an accumulation of clay.

Included with this soil in mapping are small areas of Lihen, Manning, Tonka, and Williams soils. These soils make up about 5 to 15 percent of the unit. The Lihen soils have a loamy sand surface layer. They are intermingled with areas of the Livona soil. The Manning soils have a sand and gravel substratum. They are in swales. The Tonka soils are poorly drained. They are in depressions. The Williams soils have a loam surface layer and a clay loam subsoil. They are intermingled with areas of the Livona soil.

Permeability is moderately slow in the Livona soil. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are maintaining tilth and fertility and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, buffer strips, and stripcropping help to control soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where this soil is used for range, the important forage plants are needleandthread and prairie sandreed. Green needlegrass, intermediate wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant growth and vigor. It also helps to control soil blowing. Denuding can occur along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase

the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 67. The range site is Sandy.

53C—Lihen-Sakakawea complex, 3 to 9 percent slopes. These deep, gently sloping and moderately sloping, well drained soils are on lake plains. The Lihen soil is on summits and side slopes. The Sakakawea soil is on shoulder slopes. Individual areas range from about 5 to more than 50 acres in size. They are about 45 to 60 percent Lihen soil and 20 to 40 percent Sakakawea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Lihen soil has a surface layer of dark grayish brown sandy loam about 7 inches thick. The subsoil is brown loamy sand about 7 inches thick. The next layer is grayish brown loamy sand about 4 inches thick. The substratum to a depth of about 60 inches is sand. It is light yellowish brown in the upper part and light brownish gray in the lower part. In a few places the substratum contains more than 15 percent gravel.

Typically, the Sakakawea soil has a surface layer of grayish brown loam about 6 inches thick. The subsoil is silt loam about 15 inches thick. It is very pale brown in the upper part and light yellowish brown in the lower part. The upper part of the substratum is stratified light brownish gray and light yellowish brown, mottled silt loam. The next part is stratified light brownish gray and pale yellow, mottled loam. The lower part to a depth of about 60 inches is stratified light brownish gray, mottled silty clay loam and pale yellow, mottled loamy sand. In places the substratum is clay loam.

Included with these soils in mapping are small areas of Farnuf, Lehr, Livona, Parshall, Wabek, and Williams soils. These included soils make up about 10 to 20 percent of the unit. The Farnuf and Lehr soils are on flats. The Farnuf soils have an accumulation of clay in the subsoil. The Lehr soils have a sand and gravel substratum. The Livona and Williams soils are intermingled with areas of the Sakakawea soil. The Livona soils have a sandy loam surface layer and a clay loam substratum. The Williams soils have an accumulation of clay in the subsoil. The Parshall soils have a sandy loam surface layer and subsoil. They are in swales. The Wabek soils have a sand and gravel substratum. They are on knolls.

Permeability is rapid in the Lihen soil and moderate in the Sakakawea soil. Runoff is medium on the Lihen soil and rapid on the Sakakawea soil. Available water capacity is low in the Lihen soil and high in the Sakakawea soil. Tilth is good in both soils.

Most areas are used for cultivated crops or hay. These soils are poorly suited to flax, safflower, small grain, and sunflowers and are suited to grasses and legumes for pasture and hay. The hazard of soil blowing on the Lihen soil is severe, and that on the Sakakawea soil is moderate. The hazard of water erosion is moderate on both soils. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion and soil blowing. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Leaving tall stubble on the surface helps to trap snow and thus increases the moisture supply. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are needleandthread, prairie sandreed, sand bluestem, little bluestem, blue grama, and western wheatgrass. Prairie sandreed, western wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion. Blowouts and gullies can form along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent the formation of blowouts and gullies.

The Lihen soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Sakakawea soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. The Lihen soil is droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation or supplemental watering helps to ensure the survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity of the Lihen soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover

increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Lihen and Sakakawea soils is IVe. The productivity index of the unit for spring wheat is 41. The range site of the Lihen soil is Sandy, and that of the Sakakawea soil is Thin Upland.

54E—Wabek loam, 1 to 35 percent slopes. This deep, nearly level to steep, excessively drained soil is on flats, knolls, and ridges on outwash plains and terraces. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is grayish brown gravelly coarse sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is light brownish gray very gravelly coarse sand. In places the depth to sand and gravel is as much as 14 to 20 inches.

Included with this soil in mapping are small areas of Bowdle, Divide, Manning, and Williams soils. These soils make up about 10 to 20 percent of the unit. The Bowdle soils have sand and gravel at a depth of more than 20 inches. They are on flats. The Divide soils are somewhat poorly drained and highly calcareous. They are in swales and drainageways. The Manning soils have a sandy loam surface layer and subsoil. They are on side slopes. The Williams soils have a clay loam substratum. They are intermingled with areas of the Wabek soil.

Permeability is very rapid in the Wabek soil. Runoff is rapid. Available water capacity is low. The sand and gravel restrict the depth to which plant roots can penetrate.

Most areas are used for cultivated crops or range. Because of droughtiness, this soil generally is unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings. It is best suited to range and hay.

In areas where this soil is used for range, the important forage plants are needleandthread, blue grama, and western wheatgrass. Crested wheatgrass, western wheatgrass, and slender wheatgrass are suitable hay and pasture plants. Water erosion and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant vigor and growth. It also helps to control erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The land capability classification is VIIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

55E—Cherry-Cabba complex, 9 to 60 percent slopes. These well drained soils are on dissected uplands. The deep, strongly sloping Cherry soil is on the lower side slopes and foot slopes. The shallow, moderately steep to very steep Cabba soil is on shoulder slopes and the upper side slopes. Most areas are subject to earth slippage, and slumps are common. Individual areas range from about 20 to more than 100 acres in size. They are about 45 to 65 percent Cherry soil and 25 to 45 percent Cabba soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cherry soil has a surface layer of light brownish gray silty clay loam about 3 inches thick. The subsoil is light brownish gray silty clay loam about 15 inches thick. The upper part of the substratum is light yellowish brown silt loam, the next part is light yellowish brown silty clay loam, and the lower part to a depth of about 60 inches is grayish brown clay loam. In some places, the surface layer is very dark brown and the subsoil is silty clay. In other places, the surface layer is very dark grayish brown and the subsoil is loam.

Typically, the Cabba soil is light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock. In places the depth to shale bedrock is less than 10 inches.

Included with these soils in mapping are small areas of Badland and Rhoades and Zahl soils. These included areas make up about 5 to 15 percent of the unit. The Badland consists of barren, eroding bedrock. It is on side slopes and knolls. The Rhoades soils have a dense, alkali subsoil. They are intermingled with areas of the Cherry soil. The Zahl soils are deep and have a clay loam substratum. They are on shoulder slopes.

Permeability is moderately slow in the Cherry soil and moderate in the Cabba soil. Runoff is very rapid on both soils. Available water capacity is high in the Cherry soil and low in the Cabba soil. The soft bedrock in the Cabba soil restricts the depth to which plant roots can penetrate.

Most areas are used as range; however, a few small areas, particularly of the Cherry soil, are used for cultivated crops. Because of a severe hazard of water

erosion and the slope, the Cherry soil is poorly suited to flax, safflower, small grain, and sunflowers. Because of the shallowness to bedrock, the Cabba soil generally is unsuited to cultivated crops. The soils are best suited to range. In cultivated areas of the Cherry soil, a system of conservation tillage that leaves crop residue on the surface, diversions, terraces, and grassed waterways in areas where water concentrates help to control water erosion. Conservation tillage also helps to maintain tilth and fertility and provides food and cover for wildlife. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

The important range plants are western wheatgrass, needleandthread, and little bluestem. Intermediate wheatgrass, western wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants on the Cherry soil. Because of the shallowness to bedrock, the Cabba soil generally is unsuited to hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Cherry soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cabba soil generally is unsuited to these uses. Eliminating the grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Cherry soil is IVe, and that of the Cabba soil is VIIe. The productivity index of the unit for spring wheat is 25. The range site of the Cherry soil is Silty, and that of the Cabba soil is Shallow.

57F—Badland-Cabba complex, 9 to 70 percent slopes. This unit is on dissected uplands. The shallow, strongly sloping to very steep, well drained Cabba soil is on summits and shoulder slopes. The Badland is on side slopes and knolls. In most areas earth slippage and slumps are common. Individual areas range from about 20 to more than 200 acres in size. They are about 55 to 70 percent Badland and 20 to 35 percent Cabba soil. The Badland and the Cabba soil occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Badland consists of eroding, soft, silty and clayey bedrock. It generally is on south-facing slopes. It is barren of vegetation.

Typically, the Cabba soil is light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock. In some places the depth to shale bedrock is less than 10 inches. In other places the surface layer and substratum are loamy sand.

Included with the Cabba soil and Badland in mapping are small areas of Cherry, Rhoades, and Zahl soils. These soils make up 5 to 10 percent of the unit. They are deep. The Cherry and Rhoades soils are on foot slopes. The Rhoades soils have a dense, alkali subsoil. The Zahl soils have a clay loam substratum. They are on shoulder slopes.

Permeability is moderate in the Cabba soil. Runoff is very rapid. Available water capacity is low. The soft bedrock restricts the depth to which plant roots can penetrate.

Most areas are used for range or wildlife habitat (fig. 12). Because of a severe hazard of water erosion, the slope, and the shallowness to bedrock, the Cabba soil is generally unsuited to cultivated crops and to grasses and legumes for hay or pasture. It is best suited to range.

The important range plants are little bluestem and needleandthread. Water erosion is a hazard, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important forage plants at a height that traps snow helps to store water in the soil and thus improves plant growth and vigor. It also helps to control water erosion. Wooded drainageways and brushy areas in this unit provide a diversity of habitat for wildlife.

The Badland and Cabba soil are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown on the Cabba soil for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Badland is VIIIe, and that of the Cabba soil is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Cabba soil is Shallow. A range site is not assigned to the Badland.

58B—Noonan-Williams loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils

Figure 12.—An area of Badland-Cabba complex, 9 to 70 percent slopes. This unit is best suited to range.

are on till plains. The moderately well drained, alkali Noonan soil is in swales. The well drained Williams soil is on flats and rises. Individual areas range from about 5 to more than 50 acres in size. They are about 35 to 50 percent Noonan soil and 35 to 50 percent Williams soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Noonan soil has a surface layer of dark gray loam about 6 inches thick. The subsurface layer is light brownish gray silt loam about 4 inches thick. The subsoil is dense clay loam about 37 inches thick. In sequence downward, it is dark grayish brown, brown, grayish brown, and light brownish gray. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In places the subsurface layer tongues into the subsoil.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the subsoil does not have an accumulation of clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In a few areas the noncalcareous part of the subsoil is only 3 to 5 inches thick.

Included with these soils in mapping are small areas of Hamerly, Miranda, Tonka, and Zahl soils. These included soils make up about 10 to 20 percent of the unit. The Hamerly soils are somewhat poorly drained and highly calcareous. They are on flats adjacent to depressions. The Miranda soils have salts within a depth of 16 inches. They are in swales. The Tonka soils are poorly drained. They are in depressions. The Zahl

soils have a subsoil that is calcareous throughout. They are on knolls and ridges.

Permeability is slow in the Noonan soil and moderately slow in the Williams soil. Runoff is medium on both soils. Available water capacity is moderate in the Noonan soil and high in the Williams soil. The dense, alkali subsoil of the Noonan soil restricts the depth to which plant roots can penetrate. Tilth is fair in both soils.

Most areas are used for cultivated crops or range. These soils are suited to flax, safflower, small grain, and sunflowers and to grasses and legumes for pasture or hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Because of moisture stress, small grain crops on the Noonan soil have an uneven appearance, particularly as the crop nears maturity. The main concerns in managing cultivated areas are controlling water erosion and maintaining tilth and fertility. A system of conservation tillage that leaves crop residue on the surface, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also provides food and cover for wildlife. Applying a tillage system that loosens the dense, alkali subsoil of the Noonan soil or growing deep-rooted crops, such as alfalfa and sweetclover, improves root and water penetration. Deferring tillage during wet periods helps to prevent crusting and the formation of hard clods that make a poor seedbed. Additions of organic material to the plow layer improve fertility, maintain tilth, and increase the rate of water infiltration and the available water capacity.

In areas where these soils are used for range, the important forage plants are western wheatgrass, green needlegrass, and blue grama. Intermediate wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. In the Noonan soil, the dense, alkali subsoil restricts the penetration of roots and the salts reduce the amount of water available to plants, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of the Noonan soil sometimes contain salty water.

The Noonan soil is suited to only a few of the drought- and salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Williams soil is suited to nearly all of the climatically adapted species. Supplemental watering or irrigation helps to ensure survival of seedlings on the Noonan soil. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the reduced amount of available water caused by the salts in the Noonan soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Noonan soil is IVs, and that of the Williams soil is IIe. The productivity index of the unit for spring wheat is 60. The range site of the Noonan soil is Claypan, and that of the Williams soil is Silty.

59E—Miranda-Zahl loams, 1 to 25 percent slopes. These deep soils are on moraines and till plains. The nearly level to gently rolling, moderately well drained, alkali Miranda soil is on side slopes and foot slopes. The undulating to hilly, well drained Zahl soil is on shoulder slopes, knolls, and ridges. Individual areas range from about 10 to more than 100 acres in size. They are about 55 to 70 percent Miranda soil and 20 to 35 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Miranda soil has a surface layer of light brownish gray loam about 2 inches thick. The subsoil is dense clay loam about 16 inches thick. It is very dark grayish brown in the upper part, brown in the next part, and pale brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the subsoil is exposed. In other places salts are below a depth of 16 inches. In some areas the subsoil contains less clay.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Included with these soils in mapping are small areas of Harriet, Livona, Wabek, and Williams soils. These included soils make up 5 to 20 percent of the unit. The Harriet soils are poorly drained. They are on flats. The Livona, Wabek, and Williams soils are intermingled with areas of the Zahl soil. The Livona soils have a sandy loam surface layer. The Wabek soils have sand and gravel within a depth of about 12 inches. The Williams soils have a nonalkali subsoil that is noncalcareous in the upper part.

Permeability is very slow in the Miranda soil and moderately slow in the Zahl soil. Runoff is very rapid on both soils. Available water capacity is moderate in the

Miranda soil and high in the Zahl soil. The dense, alkali subsoil of the Miranda soil restricts the depth to which plant roots can penetrate.

Most areas are used for range. Because of a severe hazard of water erosion, the restricted rooting depth in the Miranda soil, and the slope, these soils generally are unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings. They are best suited to range, pasture, and hay.

The important range plants are western wheatgrass, little bluestem, needleandthread, and blue grama. Slender wheatgrass, western wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. In the Miranda soil, the dense, alkali subsoil restricts the penetration of roots and the salts reduce the amount of water available to plants. Reestablishing vegetation is difficult in denuded areas of the Miranda soil. Maintaining an adequate cover of the important or suitable forage plants helps to prevent denuding and control water erosion and soil blowing. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying. Stock water ponds constructed in areas of the Miranda soil frequently contain salty water.

The land capability classification of the Miranda soil is VIs, and that of the Zahl soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Miranda soil is Thin Claypan, and that of the Zahl soil is Thin Upland.

60—Harriet loam. This deep, level, poorly drained, alkali, moderately saline soil is on flats on flood plains and terraces. It is occasionally flooded. Individual areas range from about 5 to more than 200 acres in size.

Typically, the surface layer is gray loam about 1 inch thick. The subsoil is clay loam about 16 inches thick. It is grayish brown in the upper part and pale brown and mottled in the lower part. The next layer is pale brown, mottled silty clay loam about 28 inches thick. The substratum to a depth of about 60 inches is light brownish gray. It is stratified clay loam and sandy loam in the upper part and clay loam in the lower part. In some places the soil is moderately saline. In other places the surface layer and subsoil are sandy loam. In some areas the substratum is sand and gravel.

Included with this soil in mapping are small areas of the saline Divide and Vallers soils and small areas of Korchea soils. These included soils make up about 5 to 15 percent of the unit. The Divide soils have a sand and gravel substratum. They are in swales. The Korchea soils are well drained. They are on rises. The Vallers soils do not have a dense, alkali subsoil. They are intermingled with areas of the Harriet soil.

Permeability is slow in the Harriet soil. Runoff also is slow. Available water capacity is moderate. A seasonal high water table is within a depth of 1 foot. The dense, alkali subsoil restricts the depth to which plant roots can penetrate.

Most areas are used for range. Because of the dense, alkali subsoil, the salinity, and the flooding, this soil generally is unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings. It is best suited to range and pasture (fig. 13).

The important range plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Tall wheatgrass, western wheatgrass, and alsike clover are suitable hay and pasture plants. The high content of salts, a reduced supply of available water, the dense, alkali subsoil, compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by maintaining an adequate cover of the important or suitable salt-tolerant forage plants and by deferring grazing during wet periods. Stock water ponds constructed in areas of this soil frequently contain salty water.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland.

62E—Rhoades-Cabba loams, 3 to 25 percent slopes. These soils are on dissected uplands. The deep, gently sloping to strongly sloping, moderately well drained, alkali Rhoades soil is on the lower side slopes and foot slopes. The shallow, moderately sloping to moderately steep, well drained Cabba soil is on shoulder slopes and the upper side slopes. Most areas are subject to earth slippage, and slumps are common. Individual areas range from about 10 to more than 100 acres in size. They are about 45 to 60 percent Rhoades soil and 25 to 40 percent Cabba soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Rhoades soil has a surface layer of light brownish gray loam about 3 inches thick. The subsoil is dense, grayish brown clay loam about 22 inches thick. The next layer is light brownish gray loam about 7 inches thick. The substratum to a depth of

Figure 13.—An area of Harriet loam. Because of a high content of salts, this soil is best suited to range and pasture.

about 60 inches is light gray loam. In some places the soil is strongly saline. In other places bedrock is at a depth of 40 to 60 inches.

Typically, the Cabba soil is light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock. In places the shale bedrock is at a depth of less than 10 inches.

Included with these soils in mapping are small areas of Badland and Belfield, Cherry, Harriet, Savage, and Zahl soils. These included areas make up about 10 to 25 percent of the unit. The Badland consists of barren, eroding bedrock. It is on side slopes. The Belfield soils do not have a dense subsoil. They are on flats. The Cherry, Savage, and Zahl soils are deep and do not have a dense, alkali subsoil. The Cherry and Savage soils are intermingled with areas of the Rhoades soil. The Zahl soils are on shoulder slopes. The Harriet soils are poorly drained. They are in drainageways.

Permeability is very slow in the Rhoades soil and moderate in the Cabba soil. Runoff is rapid on both soils. Available water capacity is moderate in the Rhoades soil and low in the Cabba soil. The dense, alkali subsoil in the Rhoades soil and the bedrock underlying the Cabba soil restrict the depth to which plant roots can penetrate.

Most areas are used as range. Because of a severe hazard of water erosion, the restricted rooting depth, and the slope, these soils generally are unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings. They are best suited to range, hay, and pasture.

The important range plants are western wheatgrass, blue grama, needleandthread, and little bluestem. Slender wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on the Rhoades soil. The Cabba soil generally is unsuited to hay and

pasture plants. In the Rhoades soil, the dense, alkali subsoil restricts the penetration of roots and the salts reduce the amount of water available to plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas because of the shallowness of the Cabba soil and the salts in the Rhoades soil. Maintaining an adequate cover of the important or suitable forage plants helps to control water erosion and prevent denuding. Stock water ponds constructed in areas of the Rhoades soil frequently contain salty water.

The land capability classification of the Rhoades soil is VIs, and that of the Cabba soil is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Rhoades soil is Thin Claypan, and that of the Cabba soil is Shallow.

63F—Cabba-Shambo-Arikara complex, 6 to 75 percent slopes. These soils are on dissected uplands. The shallow, moderately sloping to very steep, well drained Cabba soil is on shoulder slopes and the upper side slopes. The deep, moderately sloping and strongly sloping, well drained Shambo soil is on south- and west-facing side slopes. The deep, moderately sloping to very steep, well drained Arikara soil is in swales and on north- and east-facing side slopes. Individual areas range from about 50 to more than 200 acres in size. They are about 25 to 35 percent Cabba soil, 20 to 35 percent Shambo soil, and 20 to 30 percent Arikara soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cabba soil is light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock. In some places the shale bedrock is at a depth of less than 10 inches. In a few places the surface layer is loamy sand.

Typically, the Shambo soil has a surface layer of dark grayish brown clay loam about 6 inches thick. The subsoil is clay loam about 24 inches thick. It is grayish brown in the upper part and light brownish gray and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface of the Arikara soil has a 2-inch cover of partially decomposed leaves and twigs. The surface layer is dark grayish brown loam about 4 inches thick. The subsoil is clay loam about 31 inches thick. It is yellowish brown in the upper part, light yellowish brown in the next part, and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown clay loam. In places the surface layer and subsoil are silty clay loam.

Included with these soils in mapping are small areas of Badland and Zahl soils. These included areas make up about 15 to 25 percent of the unit. The Badland consists of barren, eroding bedrock. It is on side slopes and knolls. The Zahl soils are deep and are calcareous throughout. They are on summits and shoulder slopes.

Permeability is moderate in the Cabba, Shambo, and Arikara soils. Runoff is very rapid. Available water capacity is low in the Cabba soil and high in the Shambo and Arikara soils. The soft bedrock underlying the Cabba soil restricts the depth to which plant roots can penetrate.

Most areas are used for range. Because of a severe hazard of water erosion, the slope, and the restricted rooting depth in the Cabba soil, these soils generally are unsuited to cultivated crops. They are best suited to range.

The important range plants are needleandthread, little bluestem, green needlegrass, and western wheatgrass. The Arikara soil has an overstory of green ash and quaking aspen and an understory of sedges. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants on the Shambo soil. Water erosion is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas because of the slope. Maintaining an adequate cover of the important range plants helps to control water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying. The wooded Arikara soil provides a diversity of habitat for wildlife.

The Cabba and Arikara soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Shambo soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Cabba and Arikara soils is VIIe, and that of the Shambo soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Cabba soil is Shallow, and that of the Shambo soil is Silty. The Arikara soil is not assigned to a range site.

Figure 14.—An area of Southam silty clay loam used as wetland wildlife habitat.

65—Southam silty clay loam. This deep, level, very poorly drained soil is in deep depressions on till plains, moraines, and lake plains. It is subject to ponding. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is about 24 inches thick. It is very dark gray silty clay loam in the upper part and dark olive gray silty clay in the lower part. The substratum to a depth of about 60 inches is olive gray. It is silty clay in the upper part and clay in the lower part.

Included with this soil in mapping are small areas of Parnell and Tonka soils and the saline Vallers soils. These soils make up about 10 to 20 percent of the unit. The Parnell soils have an accumulation of clay in the subsoil. They are in the shallower parts of the depressions. The Tonka soils are poorly drained. They are in the shallowest parts of the depressions. The Vallers soils are poorly drained. They are on the rim of the depressions.

Permeability is slow in the Southam soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 5 feet above to 1 foot below the surface.

Most areas are used as wetland wildlife habitat (fig. 14). Because of the ponding, this soil generally is unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings. It is best suited to wetland wildlife habitat. The dominant vegetation is cattail, bulrush, and reeds. The soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation. A buffer strip of vegetation surrounding the area helps to control siltation.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

66E—Flasher-Vebar complex, 9 to 60 percent slopes. These soils are on dissected uplands. The shallow, strongly sloping to very steep, somewhat excessively drained Flasher soil is on knolls and ridges. The moderately deep, strongly sloping, well drained Vebar soil is on side slopes. Individual areas range from about 10 to more than 100 acres in size. They are

about 45 to 60 percent Flasher soil and 20 to 40 percent Vebar soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Flasher soil has a surface layer of dark grayish brown loamy sand about 4 inches thick. The next layer is yellowish brown loamy sand about 11 inches thick. Below this is soft sandstone bedrock. In places the soil is sandy loam or loam throughout.

Typically, the Vebar soil has a surface layer of very dark grayish brown sandy loam about 6 inches thick. The subsoil is sandy loam about 18 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown in the lower part. Below this is soft sandstone bedrock. In some places the bedrock is at a depth of more than 40 inches. In other places the soil is eroded and has a grayish brown surface layer.

Included with these soils in mapping are small areas of the deep Cherry, Parshall, and Wabek soils. These included soils make up about 10 to 20 percent of the unit. The Cherry and Parshall soils are intermingled with areas of the Vebar soil. The Wabek soils are on knolls.

Permeability is moderately rapid in the Flasher and Vebar soils. Runoff is very rapid. Available water capacity is very low in the Flasher soil and low in the Vebar soil. The soft sandstone bedrock underlying both soils restricts the depth to which plant roots can penetrate.

Most areas are used for range, but some areas are used for cultivated crops. Because of a severe hazard of soil blowing, a very severe hazard of water erosion, and the restricted rooting depth, these soils generally are unsuited to cultivated crops. They are best suited to range, pasture, and hay.

The important range plants are little bluestem, needleandthread, and western wheatgrass. Sand bluestem, western wheatgrass, and intermediate wheatgrass are suitable hay and pasture plants on the Vebar soil. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant growth and vigor. It also helps to control soil blowing and water erosion. Denuding can occur along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to control denuding.

The Flasher soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Vebar soil is suited to many of the climatically adapted species. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation or supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity of the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Flasher soil is VIIe, and that of the Vebar soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Flasher soil is Shallow, and that of the Vebar soil is Sandy.

67B—Rhoades-Savage complex, 1 to 6 percent slopes. These deep, nearly level and gently sloping soils are on terraces and fans. Most areas are crossed by shallow drainageways. In places the drainageways are entrenched. In areas of native grass, the surface has a characteristic microrelief. In cultivated areas the microrelief has been destroyed by tillage. The moderately well drained, alkali Rhoades soil is in microswales. The well drained Savage soil is on microswells. Individual areas range from about 5 to more than 100 acres in size. They are about 55 to 70 percent Rhoades soil and 20 to 35 percent Savage soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Rhoades soil has a surface layer of light brownish gray loam about 3 inches thick. The subsoil is dense, grayish brown clay loam about 22 inches thick. The next layer is light brownish gray loam about 7 inches thick. The substratum to a depth of about 60 inches is light gray loam. In some places it is loamy sand. In other places the surface layer is 4 to 7 inches thick. In some areas the depth to salts and gypsum is as much as 16 inches.

Typically, the Savage soil has a surface layer of dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 43 inches thick. In sequence downward, it is dark grayish brown silty clay, grayish brown silty clay, light brownish gray silty clay, and light brownish gray silty clay loam. The substratum to a

depth of about 60 inches is light brownish gray clay loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Harriet and Shambo soils. These included soils make up about 5 to 15 percent of the unit. The Harriet soils are poorly drained. They are in drainageways. The Shambo soils have a loam surface layer and subsoil. They are intermingled with areas of the Savage soil.

Permeability is very slow in the Rhoades soil and slow in the Savage soil. Runoff is medium on both soils. Available water capacity is moderate in the Rhoades soil and high in the Savage soil. The salts in the Rhoades soil reduce the amount of water available to plants. The dense, alkali subsoil in the Rhoades soil restricts the depth to which plant roots can penetrate.

Most areas are used for range, but some are used for cultivated crops, hay, or pasture. Because of the dense, alkali subsoil in the Rhoades soil, these soils are generally unsuited to cultivated crops. They are best suited to range and pasture.

The important range plants are western wheatgrass, blue grama, and green needlegrass. Slender wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. In the Rhoades soil, the dense, alkali subsoil restricts the penetration of roots and the salts reduce the amount of water available to plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding and control water erosion. Stock water ponds constructed in areas of the Rhoades soil frequently contain salty water.

The Rhoades soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The Savage soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Rhoades soil is VIs, and that of the Savage soil is IIe. The productivity index of the unit for spring wheat is 43. The range site of the Rhoades soil is Thin Claypan, and that of the Savage soil is Clayey.

71B—Miranda-Noonan loams, 1 to 6 percent slopes. These deep, nearly level and undulating, moderately well drained, alkali soils are on till plains. The Miranda soil is in swales. The Noonan soil is on flats and rises. Individual areas range from about 5 to more than 50 acres in size. They are about 45 to 65 percent Miranda soil and 25 to 45 percent Noonan soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Miranda soil has a surface layer of light brownish gray loam about 2 inches thick. The subsoil is dense clay loam about 16 inches thick. It is dark grayish brown in the upper part, brown in the next part, and pale brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam.

Typically, the Noonan soil has a surface layer of dark gray loam about 6 inches thick. The subsurface layer is light brownish gray silt loam about 4 inches thick. The subsoil is dense clay loam about 37 inches thick. In sequence downward, it is dark grayish brown, brown, grayish brown, and light brownish gray. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some places the subsurface layer tongues into the subsoil. In other places the subsoil is not dense.

Included with these soils in mapping are small areas of Williams and Zahl soils. These included soils make up about 1 to 10 percent of the unit. The Williams soils do not have a dense, alkali subsoil. They are on rises. The Zahl soils have a subsoil that is calcareous throughout. They are on knolls.

Permeability is very slow in the Miranda soil and slow in the Noonan soil. Runoff is medium on both soils. Available water capacity is moderate. The salts in the Miranda soil reduce the amount of water available to plants. The dense, alkali subsoil in both soils restricts the depth to which plant roots can penetrate.

Most areas are used for range, but some areas are used for cultivated crops. Because of the restricted rooting depth and a moderate hazard of water erosion, these soils generally are unsuited to cultivated crops. They are best suited to range, hay, and pasture. Returning the cultivated areas to a permanent cover of grass helps to control water erosion.

The important range plants are western wheatgrass, blue grama, and green needlegrass. Western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. The dense, alkali subsoil restricts the penetration of roots and the salts reduce the amount of water available to plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable forage plants helps to prevent

denuding and control water erosion. Stock water ponds constructed in areas of the Miranda soil frequently contain salty water.

The Miranda soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Noonan soil is suited to only a few of the drought and salt-tolerant climatically adapted species. Supplemental watering or irrigation helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification of the Miranda soil is VIs, and that of the Noonan soil is IVs. The productivity index of the unit for spring wheat is 0. The range site of the Miranda soil is Thin Claypan, and that of the Noonan soil is Claypan.

76—Pits, gravel. This unit consists of areas from which soil material has been removed so that the underlying sand and gravel can be mined. Individual areas range from about 5 to 20 acres in size.

Included in this unit are small areas of Bowdle, Lehr, and Wabek soils. These soils make up about 15 to 25 percent of the unit. They have sand and gravel at a shallow or moderate depth.

The vertical walls of the pits are generally unstable and subject to slipping and slumping. Most of the acreage is idle land or is used for range or wildlife habitat. The unit generally is unsuited to cultivated crops, hay, pasture, and the trees and shrubs grown as windbreaks and environmental plantings. Smoothing the surface, replacing topsoil, and adding manure or other organic material help to control soil blowing and improve the suitability for uses that require the growth of plants.

No land capability classification or range site is assigned. The productivity index for spring wheat is 0.

80E—Vebar-Flasher-Zahl complex, 6 to 25 percent slopes. These soils are on dissected uplands and truncated till plains. The moderately deep, moderately sloping and strongly sloping, well drained Vebar soil is on the lower side slopes and foot slopes. The shallow, moderately sloping to moderately steep, somewhat excessively drained Flasher soil is on the upper side slopes and knolls. The deep, moderately sloping to moderately steep, well drained Zahl soil is on shoulder slopes. Individual areas range from about 10 to more than 200 acres in size. They are about 25 to 50 percent Vebar soil, 20 to 35 percent Flasher soil, and 15 to 35 percent Zahl soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Vebar soil has a surface layer of very dark grayish brown sandy loam about 6 inches thick. The subsoil is sandy loam about 18 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown in the lower part. Below this is soft sandstone bedrock. In some places the bedrock is at a depth of more than 40 inches. In other places the soil is eroded and has a grayish brown surface layer.

Typically, the Flasher soil has a surface layer of dark grayish brown loamy sand about 4 inches thick. The next layer is yellowish brown loamy sand about 11 inches thick. Below this is soft sandstone bedrock. In places the soil is sandy loam throughout.

Typically, the Zahl soil has a surface layer of dark grayish brown loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam.

Included with these soils in mapping are small areas of the deep Livona, Manning, Parshall, Wabek, and Williams soils. These included soils are intermingled with areas of the Vebar soil. They make up about 10 to 20 percent of the unit. The Livona soils have a sandy loam surface layer and a clay loam substratum. The Manning and Wabek soils have a sand and gravel substratum. The Parshall soils have a sandy loam surface layer and subsoil. The Williams soils have a clay loam substratum.

Permeability is moderately rapid in the Vebar and Flasher soils and moderately slow in the Zahl soil. Runoff is rapid on all three soils. Available water capacity is low in the Vebar soil, very low in the Flasher soil, and high in the Zahl soil. The soft bedrock underlying the Flasher and Vebar soils restricts the depth to which plant roots can penetrate.

Most areas are used for range. Because of severe hazards of water erosion and soil blowing and the slope, these soils generally are unsuited to cultivated crops. They are best suited to range and pasture.

The important range plants are needleandthread, prairie sandreed, and little bluestem. Intermediate wheatgrass, western wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. Water

erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas because of the shallowness of the Flasher soil. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soil and thus improves plant growth and vigor. It also helps to control soil blowing and water erosion. Gullies can form along cattle trails and where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Vebar soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Flasher and Zahl soils generally are unsuited to these uses. The Vebar soil is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation or supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion. Trees and shrubs can be grown on the Zahl and Flasher soils for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Vebar soil is IVe, and that of the Flasher and Zahl soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Vebar soil is Sandy, that of the Flasher soil is Shallow, and that of the Zahl soil is Thin Upland.

81F—Cabba-Badland complex, 9 to 70 percent slopes. This unit is on dissected uplands. The shallow, strongly sloping to very steep, well drained Cabba soil is on summits and shoulder slopes. The Badland is on side slopes and knolls. Most areas are subject to earth slippage, and slumps are common. Individual areas range from about 20 to more than 100 acres in size. They are about 45 to 65 percent Cabba soil and 15 to 35 percent Badland. The Cabba soil and Badland occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cabba soil is light brownish gray loam to a depth of about 19 inches. Below this is soft shale bedrock. In some places the shale bedrock is at a depth of less than 10 inches. In other places the surface layer and substratum are sandy loam or loamy sand.

Typically, the Badland consists of eroding, soft, silty and clayey bedrock. It generally is on south-facing slopes. It is barren of vegetation.

Included with this soil and miscellaneous area in mapping are small areas of the deep Cherry, Rhoades, and Zahl soils. These soils make up about 10 to 30 percent of the unit. The Cherry soils have a silty clay loam subsoil. They are on foot slopes. The Rhoades soils have a dense, alkali subsoil. They are in swales. The Zahl soils have a clay loam subsoil. They are on summits.

Permeability is moderate in the Cabba soil. Runoff is very rapid. Available water capacity is low. The soft bedrock restricts the depth to which plant roots can penetrate.

Most areas are used for range and wildlife habitat. Because of a severe hazard of water erosion, the slope, and the shallowness to bedrock, the Cabba soil generally is unsuited to cultivated crops, to grasses and legumes for hay or pasture, and to the trees and shrubs grown as windbreaks and environmental plantings. It is best suited to range.

The important range plants are little bluestem and needleandthread. Water erosion is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important forage plants at a height that traps snow helps to store water in the soil and thus improves plant growth and vigor. It also helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to control gullying. The wooded drainageways and brushy areas in this unit provide a diversity of habitat for wildlife.

The land capability classification of the Cabba soil is VIIe, and that of the Badland is VIIIe. The productivity index of the unit for spring wheat is 0. The range site of the Cabba soil is Shallow. The Badland is not assigned to a range site.

82E—Zahl-Williams-Parnell complex, 0 to 25 percent slopes. These deep soils are on moraines. The undulating to hilly, well drained Zahl soil is on shoulder slopes and knolls. The nearly level to hilly, well drained Williams soil is on side slopes. The level, very poorly drained Parnell soil is in depressions. It is subject to ponding. Individual areas range from about 25 to more than 700 acres in size. They are about 40 to 50 percent Zahl soil, 20 to 35 percent Williams soil, and 15 to 25 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of dark gray loam about 5 inches thick. The subsoil is light brownish gray loam about 15 inches thick. The substratum to a depth of about 60 inches is light yellowish brown and light olive brown, mottled clay loam. In places the surface layer is light brownish gray.

Typically, the Williams soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 30 inches thick. In sequence downward, it is brown, grayish brown, light olive brown and calcareous, and light brownish gray and calcareous. The substratum to a depth of about 60 inches is light brownish gray clay loam. In some places the subsoil does not have an accumulation of clay. In other places the noncalcareous part of the subsoil is only 3 to 5 inches thick. In a few areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface of the Parnell soil has a 1-inch cover of roots and partially decomposed stems and leaves. The surface layer is about 11 inches thick. It is dark gray. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is dark gray clay about 19 inches thick. Below this to a depth of about 60 inches is gray, mottled clay. In places the soil has a substratum at a depth of 30 to 50 inches.

Included with these soils in mapping are small areas of Miranda, Noonan, Southam, Tonka, and Wabek soils and the saline Vallers soils. These included soils make up about 5 to 15 percent of the unit. The Miranda and Noonan soils have a dense, alkali subsoil. They are in swales. The Southam soils are nearly continuously ponded. They are in deep depressions. The Tonka soils are poorly drained. They are in shallow depressions. The Vallers soils are poorly drained and saline. They are on the rim of depressions and on flats between the depressions. The Wabek soils have a sand and gravel substratum. They are intermingled with areas of the Zahl soil.

Permeability is moderately slow in the Zahl and Williams soils and slow in the Parnell soil. Runoff is very rapid on the Zahl and Williams soils and ponded on the Parnell soil. Available water capacity is high in all three soils. A seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil.

Most areas are used for range. Because of the slope, a moderate hazard of soil blowing on the Zahl soil, a very severe hazard of water erosion on the Zahl and Williams soils, and the wetness of the Parnell soil, these soils generally are unsuited to cultivated crops. They are best suited to range, pasture, and hay.

The important range plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Zahl and Williams soils and slough sedge and rivergrass on the Parnell soil. Intermediate wheatgrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on the Zahl and Williams soils. If drained, the Parnell soil is suited to reed canarygrass. Trampling, compaction, and root shearing are problems if the range or pasture is grazed when the Parnell soil is wet. They can be overcome by deferring grazing during wet periods. Soil blowing on the Zahl soil and water erosion on the Williams and Zahl soils are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The Zahl soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Williams soil and drained areas of the Parnell soil are suited to these uses. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Zahl soil is VIe, that of the Williams soil is IVe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, that of the Williams soil is Silty, and that of the Parnell soil is Wetland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should

encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 44,600 acres in the survey area, or less than 4 percent of the total acreage, meets the soil requirements for prime farmland. Nearly all of this prime farmland is used for crops. The principal crops grown on this land are wheat and barley.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name on the following list. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

3	Tonka silt loam (where drained)
10	Makoti silty clay loam, 1 to 3 percent slopes
14	Divide loam, 0 to 3 percent slopes
17	Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
32	Bowbells loam, 1 to 3 percent slopes
35	Bowbells-Tonka complex, 0 to 3 percent slopes (where drained)

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lyle Samson, agronomist, and Richard Maluski, district conservationist, Soil Conservation Service, prepared this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 56 percent of Mountrail County is cultivated. In 1986, about 332,600 acres was used for close-grown crops, 22,000 acres for row crops, and 60,000 acres for forage crops *(6)*. The acreage of summer fallow was 230,000 in 1983, 210,000 in 1984, and 240,000 in 1985. The acreage used for sunflowers has fluctuated, but it generally is increasing. It averaged 34,900 acres per year from 1981 to 1985. It was 16,000 acres in 1981 and 42,900 acres in 1985. The acreage used for corn and forage has been relatively stable since 1981. In 1986, the acreages of the principal close-grown crops were as follows: spring wheat, 55,000 acres; durum wheat, 175,000 acres; winter wheat, 5,000 acres; barley, 70,000 acres; oats, 21,000 acres; rye, 1,600 acres; and flax, 5,000 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 20,200 acres, corn for grain on 700 acres, and corn for silage on 1,100 acres. Alfalfa was grown on 24,000 acres and other hay crops on 36,000 acres. Small acreages were planted to mustard, rye, buckwheat, lentils, millet, safflower, and soybeans.

The potential of the soils in Mountrail County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the survey area. Crops that are not commonly grown but

are suitable include dry edible beans, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on most of the soils in Mountrail County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Flasher, Lihen, Livona, Manning, Parshall, and Vebar soils.

Cabba, Divide, Hamerly, Sakakawea, Vallers, and Zahl soils have a relatively high content of lime and are susceptible to soil blowing in the spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as Arikara, Cabba, Cherry, Flasher, Lihen, Max, Miranda, Rhoades, Sakakawea, Shambo, Vebar, Wabek, Williams, and Zahl. The hazard is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover on the surface. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of approved herbicide can help to eliminate the need for summer fallow tillage. Cover crops are also effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. A cropping sequence that includes grasses and legumes, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, crop success for the year is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are stubble mulch, mulch tillage, no-till, stripcropping, cover crops, crop residue management, applications of fertilizer, and standing stubble, which traps snow. When fallow is used to carry moisture over to the next season, a cover of crop residue is essential during winter to prevent excessive moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer or barnyard manure, green manure crops, and a cropping sequence that includes legumes.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the Miranda, Noonan, and Rhoades soils that have an alkali subsoil and on the Cherry, Makoti, Nutley, Savage, Shambo, and Southam soils that have a silty clay, clay loam, or silty clay loam surface layer. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Management of Saline and Alkali Soils

Saline and alkali soils make up nearly 3 percent of Mountrail County. Saline soils make up about 1 percent, or about 11,000 acres; alkali soils make up less than 1 percent, or about 4,000 acres; and saline-alkali soils make up nearly 2 percent, or about 20,000 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in Mountrail County are phases of the Divide, Hamerly, and Vallers series.

Saline soils generally develop in areas of restricted drainage, such as those adjacent to sloughs and waterways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the

soil water. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts are generally not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can produce salt-tolerant crops and forage. Barley is the most salt-tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt-tolerant once they are established. Continuous cropping is beneficial because it reduces the rate of evaporation and salt accumulation in the surface layer.

Alkali soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soils. The alkali soils in Mountrail County are phases of the Belfield and Noonan series. Locally, alkali soils are known as "alkali," or "gumbo."

Alkali soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the alkali soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Alkali soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, as the water table lowers, rainwater gradually leaches the salts from the surface to lower horizons. During this leaching process, the clay in the soil becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, alkali subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. An example of soils that have a dense, alkali subsoil are the Noonan soils.

As the leaching by soil water continues, the sodium is gradually moved lower in the soil profile and eventually is carried below rooting depth. The result is a more manageable soil. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonalkali soil. This change requires a long period, usually centuries *(5)*.

If plowed, alkali soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils are unfavorable for plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by depth to the dense subsoil.

Identification of alkali soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of soil moisture stress, is a useful indicator of the level of alkalinity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of alkalinity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of alkalinity on vegetative growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the vegetative growth of these crops.

The variability of alkali soils can cause management problems. The soils that have a dense, alkali subsoil near the surface, such as Miranda and Rhoades, are better suited to grass than to small grain and sunflowers.

Timely tillage is an important management need in areas of the alkali soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soil puddles and crusts. If the soil is tilled when too dry, tillage and seeding implements cannot easily penetrate the soil. Deep plowing and chemical amendments can help to reclaim alkali soils, but they may not be feasible. To be effective, deep tillage should reach to the alkali subsoil and mix several inches of the subsoil with the topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of alkali soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-alkali soils develop in areas of restricted

drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, alkali subsoil has formed. The saline-alkali soils in Mountrail County are Harriet, Miranda, and Rhoades. The management needs and crop responses on these soils are a combination of those on saline soils and those on alkali soils.

Additional information about management or reclamation of saline and alkali soils is available from the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the Cooperative Extension Service.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In Mountrail County, a productivity index of 100 was considered equal to an average yield of 34 bushels per acre of spring wheat. Multiplying the productivity index by 34 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. The unit Williams-Zahl loams, 3 to 6 percent slopes, for example, has a productivity index of 71, which when multiplied by 34 and then divided by 100, converts to 24, which is the expected annual yield of spring wheat in bushels per acre for this map unit. (See table 5.)

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use. No class I land is recognized in North Dakota because of the climate.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Brian Gerbig, range conservationist, Soil Conservation Service, helped prepare this section.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1986, approximately 420,000 acres in Mountrail County, or about 36 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains and moraines and on loamy, sloping residual uplands (fig. 15). Much of it occurs as hilly to very steep, well drained or excessively drained soils or as level and nearly level, moderately well drained to poorly drained, alkali soils. The soils are generally unsuited or at best poorly suited to cultivated crops.

In 1986, the farms and ranches in the county had about 35,000 head of cattle. Of that number, about 1,200 were milk cows *(6)*. Most of the ranches include a cow-calf operation. A number also include a yearling operation, which adds flexibility during periods of low or high forage production. On some ranches used for a cow-calf operation, sheep are raised for improved income stability.

Because of the relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in the spring and fall. Droughts of short duration are common. As a result, cool-season pastures cannot be grazed in the fall during many years. Generally, large amounts of hay and feed are needed because of the long winters. Hay was harvested on about 60,000 acres in 1986 *(6)*.

Range Site and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is improperly grazed, some of the climax vegetation decreases in abundance and some of it increases. Also, plants that were not part of the native plant community invade the site.

Figure 15.—An area in the valley of the White Earth River. Because of the slope, flooding, and a shallow rooting depth, most of the soils in the valley are used for range.

Decreaser plants are the species that decrease in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by continual heavy grazing. Most invader species have little grazing value.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community resembles the natural plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for each soil, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, stage of growth, exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and the grazing system to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, development of watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Good management is one of the most overlooked means of improving rangeland. Proper fencing provides the opportunity to achieve good management.

The following paragraphs describe the range sites in Mountrail County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Shallow, Shallow to Gravel, Silty, Thin Claypan, Thin Upland, Very Shallow, Wetland, and Wet Meadow.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants include blue grama, prairie junegrass, Pennsylvania sedge, and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and gray sagewort, make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush, western snowberry, and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, needleandthread, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, fringed sagebrush, and upland sedges. Further deterioration results in the dominance of blue grama,

upland sedges, western ragweed, and fringed sagewort and the invasion of Kentucky bluegrass.

Very few problems affect management of this site. The water infiltration rate is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by good management if the remnant climax species remain on the site in sufficient numbers and are evenly distributed.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species include blue grama and upland sedges. The common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. Fringed sagewort is a common shrub on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in the dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, broom snakeweed, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing vegetation is difficult in denuded areas. Careful management that maintains the abundance of the naturally dominant plants helps to maintain forage production and control water erosion.

Limy Subirrigated range site. Tall grasses dominate this site. The principal species are little bluestem, big bluestem, and switchgrass. Other species include indiangrass, slim sedge, fescue sedge, and Baltic rush. The common forbs are Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod. They make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in the dominance of Kentucky bluegrass, Baltic rush, common spikerush, and low-growing sedges, grasses, and forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species include porcupinegrass, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, commonly grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in the dominance of blue grama, sedges, Kentucky bluegrass, and unpalatable forbs.

Because of its position on the landscape, this site is frequently overgrazed. Separate fencing of this site generally is not feasible because of the small size or the shape of the areas. As a result of flooding and the runoff received by these areas, this is a very productive site when properly managed. A planned grazing system can restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and other salt-tolerant species, including western wheatgrass and slender wheatgrass. Other species include alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in the dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted desirable salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, sand bluestem, and sand dropseed. Other species include blue grama, prairie junegrass, little bluestem, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, little bluestem, sand bluestem, and leadplant amorpha. The plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in the dominance of blue grama, upland sedges, and unpalatable forbs, such as fringed sagewort and gray sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and that do not allow the animals to concentrate in an area for too long a time are needed. In severely overgrazed areas, blowouts are common. On large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. The vegetation in areas where the site is in fair or poor condition responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread and prairie sandreed. Other species include prairie junegrass, blue grama, western wheatgrass, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, and several forbs. Further deterioration results in the dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and gray sagewort.

A moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains the abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Shallow range site. The principal grasses on this site are little bluestem, needleandthread, western wheatgrass, plains muhly, blue grama, and sideoats grama. Grasses make up about 75 percent of the vegetation. Upland sedges make up about 10 percent. Forbs, such as blacksamson, hairy goldaster, skeletonweed, purple prairie-clover, and stiff sunflower, also make up about 10 percent. Shrubs and half-shrubs, such as fringed sagebrush, western snowberry, and prairie rose, make up the rest.

Continual heavy grazing by cattle results in a decrease in the abundance of little bluestem, needleandthread, prairie sandreed, and stiff sunflower. Initially, western wheatgrass tends to increase in abundance, but then it decreases. Blue grama, upland sedges, red threeawn, and fringed sagebrush are increasers. Further deterioration results in the dominance of blue grama, upland sedges, fringed sagebrush, and other unpalatable forbs.

Because of a low available water capacity, forage production is limited on this site. Water erosion is a hazard in areas that have a slope of more than 5 percent. Gullies form readily along cattle trails and in denuded areas. Management that maintains the key plants and cross fencing, which helps to control the pattern of livestock traffic, help to maintain productivity. A planned grazing system is an excellent method of restoring productivity if the site has deteriorated.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species include plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red threeawn, and upland sedges. Further deterioration results in the dominance of blue grama, upland sedges, Kentucky bluegrass, unpalatable forbs, and fringed sagebrush.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly. Because of the limited amount of available water, the plant community should be kept near its potential and plant vigor should be maintained in order to optimize available moisture use.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species include prairie junegrass, prairie dropseed, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of weedy species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in the dominance of blue grama, threadleaf sedge, needleleaf sedge, Kentucky bluegrass, and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They also are beneficial in areas where gullies have already formed. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species include prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in the dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Stock water pits should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species include plains muhly, sideoats grama, red threeawn, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in the dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They also are beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas.

Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. The site has a mixture of cool- and warm-season, mid grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species include prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, and upland sedges. Further deterioration results in the dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can readily form along cattle trails and in denuded areas. The site is frequently overgrazed. Once it is in fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control livestock traffic patterns.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species include American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in the dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and deferment of grazing when the site is wet help to maintain the climax vegetation.

Wet Meadow range site. Mid sedges dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species include Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in the dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system that includes proper fencing helps to maintain the climax vegetation. The site is an excellent source of quality hay.

Woodland, Windbreaks, and Environmental Plantings

Bruce C. Wight, forester, Soil Conservation Service, helped prepare this section.

Mountrail County has approximately 8,700 acres of native woodland *(9)*. Most of this woodland is along the Little Knife and White Earth Rivers and the Missouri River breaks overlooking Lake Sakakawea in the southwestern and western parts of the county. The woodland along the Little Knife River is confined mostly to the side slopes. Because of salinity, the woody vegetation on the flood plains is mostly shrubs. The areas along Shell Creek and East Shell Creek also have more shrubs than trees. Trees and shrubs also grow on the fringe of wetlands on the Missouri Coteau in the northern third of the county. The woodland on side slopes in the river valleys is primarily in areas of Arikara, Cabba, Max, Shambo, and Zahl loams. The woodland on the Missouri River breaks is primarily in areas of Cabba and Cherry soils. The woodland on bottom land is mostly in areas of Korchea and Straw soils. The woodland on the fringe of the wetlands on the Missouri Coteau is in areas of Hamerly and Vallers soils.

The wooded areas on the bottom land and the associated side slopes along the rivers primarily support

American elm, green ash, bur oak, quaking aspen, and various willow species. Other trees and shrubs associated with the dominant species include boxelder, cottonwood, hawthorn, American plum, common chokecherry, currant, beaked hazel, juneberry, redosier dogwood, Woods rose, silverberry, and silver buffaloberry. Other trees and shrubs associated with the ash are the same as those on the river valley uplands with the addition of Rocky Mountain juniper, creeping juniper, rabbitbrush, and shrubby cinquefoil. Along Shell and East Shell Creeks, most of the woody plants are shrubs, especially common chokecherry and silver buffaloberry. The principal species on the fringe of the wetlands in northern Mountrail County are quaking aspen and various willow species.

The early settlers used the trees for fuel, lumber, and fenceposts. At the turn of the century, a sawmill at White Earth cut native trees into lumber for local use. Currently, there is a renewed interest in using trees for fuel. The principal uses, however, are for protection and esthetic purposes. The trees protect the soil, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Mountrail County since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock. Since the 1930's, more than 4,000,000 trees have been planted on about 6,700 acres by county farmers and landowners assisted by the Soil Conservation Service and the Fort Berthold and North Mountrail Soil Conservation Districts. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

Before a windbreak is established, the purpose of the planting, the suitability of the soil for the various species of trees and shrubs, the location and design of the windbreak, and the availability of a source of hardy and adapted trees and shrubs should be considered. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the trees and shrubs are planted, and regrowth of the competing vegetation should be controlled for the life of the windbreak. Some replanting of the trees and shrubs may be necessary during the first 2 years after planting.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are predicted to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

David D. Dewald, biologist, Soil Conservation Service, helped prepare this section.

The chief recreational areas in Mountrail County are along the shores of Lake Sakakawea. The lake provides opportunities for a variety of recreational activities. Created by the Garrison Dam, it has become one of North Dakota's largest recreational areas. The survey area has many miles of Lake Sakakawea shoreline available for recreation. Four public campgrounds are managed by the Army Corps of Engineers. The facilities range from primitive to modern. The lake provides excellent fishing for a wide variety of species, including walleye, salmon, smallmouth bass, and northern pike.

Four other lakes in the county provide opportunities for fishing and some primitive camping. These are Powers Lake, White Earth Dam, Stanley Reservoir, and Clearwater Lake. Northern pike, walleye, bluegill, crappie, perch, and bass are the main fish species in the lakes.

Four towns in the county have picnicking and limited camping facilities. No state parks are located in the county.

Approximately 7,100 acres of waterfowl production

areas, 3,900 acres of national wildlife refuge, 4,600 acres of wildlife management areas, and 32,000 acres of state school land provide opportunities for hunting and for other recreational activities, such as hiking, bird-watching, and cross-country skiing.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

David D. Dewald, biologist, Soil Conservation Service, helped prepare this section.

Mountrail County provides a diverse habitat for wildlife, although agricultural activity has reduced the quality and quantity of the habitat. Approximately 56 percent of the rangeland in the county has been converted to cropland. Native woodland provides wildlife habitat in less than 1 percent of the county. The wetlands and woody draws in the county enhance the habitat for wildlife.

Drainage of hydric soils has removed approximately 30 percent of the wetlands in the county. The remaining wetlands provide habitat for waterfowl and furbearers. Lake Sakakawea provides limited habitat for migratory waterfowl and furbearers.

Private landowners have planted more than 4 million trees in farmstead and feedlot shelterbelts, in field windbreaks, and in areas of wildlife habitat. Also, they have protected approximately 27,000 acres of wetland basins from drainage by conveying their drainage rights to the federal government through the Small Wetlands Acquisition Program. Conservation tillage systems in areas used for crop production have increased the amount of food and cover available for migratory and resident wildlife.

Public lands provide excellent wildlife habitat. About 7,000 acres is managed by the U.S. Fish and Wildlife Service as waterfowl production areas, and about 4,000 acres is managed as wildlife refuges. The North Dakota Game and Fish Department manages approximately 4,500 acres of wildlife management areas.

Important game bird species in the county are gray partridge, sharp-tailed grouse, ducks, geese, mourning dove, and ring-necked pheasant. The giant Canada goose has been reintroduced into the county. Mammals that are hunted include red fox, coyote, white-tailed deer, mule deer, antelope, cottontail rabbit, and white-tailed jackrabbit. Beaver, muskrat, mink, raccoon, and badger are trapped in the county.

A wide variety of fish species inhabit the waters in the county. Northern pike, walleye pike, yellow perch, white bass, largemouth and smallmouth bass, bullhead, bluegill, and chinook salmon can be caught. Most of the fish are in the public lakes. Lake Sakakawea has the largest variety of fish species. The potential for developing additional fishery resources is limited.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, silver buffaloberry, and silver sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas

produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include gray partridge, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, sharp-tailed grouse, meadowlark, and lark bunting.

About 73,000 acres in the county, or nearly 6 percent of the total acreage, meets the requirements for hydric soils. The map units in the survey area that generally display hydric conditions are listed at the end of this paragraph. They are considered hydric soils unless they have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation. The soil maps in this survey area do not identify the drained areas. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units." Most of the wetland wildlife habitat in the survey area is in areas of hydric soils.

2	Parnell silt loam
3	Tonka silt loam
4	Vallers loam, saline
17	Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
35	Bowbells-Tonka complex, 0 to 3 percent slopes (Tonka part)
60	Harriet loam
65	Southam silty clay loam
82E	Zahl-Williams-Parnell complex, 0 to 25 percent slopes (Parnell part)

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect

public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability

of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are

indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and

organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional*

that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(14)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiborolls (*Argi*, meaning an argillic horizon, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Typic Argiborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (13)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (14)*. Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arikara Series

The Arikara series consists of deep, well drained, moderately permeable soils on dissected uplands.

These soils formed in colluvium. Slope ranges from 6 to 75 percent.

Typical pedon of Arikara loam, in an area of Cabba-Shambo-Arikara complex, 6 to 75 percent slopes; 50 feet east and 1,600 feet south of the northwest corner of sec. 36, T. 154 N., R. 92 W.

Oi—2 inches to 0; litter of partially decomposed leaves and twigs; abrupt smooth boundary.

A—0 to 4 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine and many very fine roots; 1-inch-thick layer of black (10YR 2/1) charcoal at a depth of about 2 inches; slightly acid; clear wavy boundary.

Bw1—4 to 13 inches; yellowish brown (10YR 5/4) clay loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, and fine and common very fine roots; few faint clay films on faces of peds; very dark grayish brown (10YR 3/2) organic stains on faces of prisms; neutral; gradual wavy boundary.

Bw2—13 to 27 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few coarse, medium, fine, and very fine roots; slight effervescence; mildly alkaline; gradual wavy boundary.

Bk—27 to 35 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few coarse, medium, fine, and very fine roots; common filaments and fine irregularly shaped soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C—35 to 60 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; massive; hard, friable, slightly sticky and slightly plastic; about 10 percent gravel; thin crust of lime on the underside of pebbles; few filaments of lime; strong effervescence; mildly alkaline.

The depth to lime is 12 to 16 inches. The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The Bw horizon has chroma of 2 to 4. Some pedons do not have a Bk horizon. The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 2 to 4.

Belfield Series

The Belfield soil consists of deep, well drained, slowly permeable soils on terraces and fans. These soils formed in alluvium. Slope ranges from 1 to 3 percent.

Typical pedon of Belfield silt loam, 1 to 3 percent slopes, 2,600 feet south and 100 feet west of the northeast corner of sec. 6, T. 151 N., R. 92 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

B/E—9 to 13 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist (B); weak medium columnar structure parting to strong fine angular blocky; slightly hard, friable, sticky and plastic; common very fine roots; common gray (10YR 5/1) coatings on faces of peds (E); common faint clay films on faces of some peds and in pores; neutral; clear smooth boundary.

Bt1—13 to 17 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to strong fine angular blocky; hard, friable, sticky and plastic; common very fine roots; many distinct clay films on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—17 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, very sticky and very plastic; common very fine roots; common distinct clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Bk—25 to 35 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; common filaments of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C—35 to 60 inches; light yellowish brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; massive; hard, firm, sticky and plastic; disseminated lime throughout; strong effervescence; moderately alkaline.

The B/E horizon has value of 3 to 6 (2 or 3 moist) and chroma of 1 or 2. It is silty clay, silty clay loam, or loam. The Bt horizon has value of 3 or 4 (2 or 3 moist). It is silty clay or silty clay loam. The Bk horizon has value of 4 or 5. The C horizon has value of 5 or 6 and chroma of 2 to 4. It is silty clay loam, clay loam, or silty clay. Some pedons have salts below a depth of 20 inches.

Bowbells Series

The Bowbells series consists of deep, moderately well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till and alluvium. Slope ranges from 0 to 6 percent.

Typical pedon of Bowbells loam, 1 to 3 percent slopes, 110 feet east and 280 feet north of the southwest corner of sec. 25, T. 151 N., R. 89 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium and fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; slightly acid; abrupt smooth boundary.

A—5 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; medium acid; clear smooth boundary.

Bt1—7 to 15 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common very fine roots; many distinct clay films on faces of peds and lining pores; slightly acid; clear wavy boundary.

Bt2—15 to 23 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common very fine roots; many distinct clay films on faces of peds and lining pores; slightly acid; clear wavy boundary.

Bw—23 to 30 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to moderate fine and very fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; about 10 percent gravel; lime disseminated throughout and in common fine irregularly shaped soft masses; slight effervescence; neutral; clear wavy boundary.

Bk—30 to 60 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky and plastic; about 5 percent gravel; lime disseminated throughout and in common medium irregularly shaped soft masses; violent effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to 44 inches. The depth to lime ranges from 21 to 44 inches.

The A horizon has chroma of 1 or 2. The Bt horizon has value of 3 to 5 (2 to 4 moist) and chroma of 2 or 3. It is clay loam or loam. Some pedons do not have a Bw horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 7 (3 to 5 moist), and chroma of 2 to 4. In some pedons it is mottled in the lower part. It is loam or clay loam. Some pedons have a BCk or C horizon.

Bowdle Series

The Bowdle series consists of deep, well drained soils on terraces and outwash plains. These soils formed in glaciofluvial deposits. They are underlain by sand and gravel at a depth of about 26 inches. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 1 to 3 percent.

Typical pedon of Bowdle loam, 1 to 3 percent slopes, 2,475 feet west and 1,050 feet north of the southeast corner of sec. 11, T. 154 N., R. 93 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

Bw—7 to 21 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

Bk—21 to 26 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; about 10 percent gravel; thin crust of lime on the underside of pebbles; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

2C1—26 to 32 inches; brown (10YR 5/3) gravelly coarse sand, dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; thin crust of lime on the underside of pebbles; about 30 percent gravel; violent effervescence; moderately alkaline; gradual wavy boundary.

2C2—32 to 60 inches; grayish brown (2.5Y 5/2) very gravelly coarse sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; about 40 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 28 inches. The depth to lime is 20 to 22 inches. The depth to sand and gravel ranges from 20 to 33 inches.

The Bw horizon has value of 3 or 4 (2 or 3 moist) and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is loam or gravelly loam in which the content of gravel is 5 to 25 percent. The 2C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 to 4. It is gravelly sand, very gravelly sand, gravelly coarse sand, or very gravelly coarse sand.

Cabba Series

The Cabba series consists of shallow, well drained, moderately permeable soils on dissected uplands. These soils formed in material weathered from soft siltstone and shale bedrock. Slope ranges from 6 to 70 percent.

Typical pedon of Cabba loam, in an area of Cherry-Cabba complex, 9 to 60 percent slopes; 2,630 feet east and 1,050 feet south of the northwest corner of sec. 20, T. 150 N., R. 92 W.

A—0 to 3 inches; light brownish gray (2.5Y 6/2) loam, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; about 10 percent gravel; slight effervescence; mildly alkaline; clear smooth boundary.

AC—3 to 7 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; about 5 percent gravel; lime disseminated throughout and in common filaments; strong effervescence; mildly alkaline; clear wavy boundary.

C—7 to 19 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; few nests of gypsum; few filaments of lime; slight effervescence; mildly alkaline; clear smooth boundary.

Cr—19 to 60 inches; light gray (5Y 7/1), soft shale bedrock, gray (5Y 5/1) moist; few very fine roots between plates and in fissures; mildly alkaline.

The depth to bedrock ranges from 10 to 20 inches. The A horizon has hue of 2.5Y or 10YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 or 3. The AC horizon has hue of 2.5Y or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is loam, silt loam, clay loam, or silty clay loam. Some pedons have a Bk horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 1 to 4. It is loam, silt loam, or silty clay loam. The Cr horizon is soft siltstone or shale.

Cherry Series

The Cherry series consists of deep, well drained, moderately slowly permeable soils on dissected uplands. These soils formed in alluvium. Slope ranges from 9 to 15 percent.

Typical pedon of Cherry silty clay loam, in an area of Cherry-Cabba complex, 9 to 60 percent slopes; 2,250 feet east and 850 feet south of the northwest corner of sec. 20, T. 150 N., R. 92 W.

A—0 to 3 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark brownish gray (2.5Y 4/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, sticky and plastic; few fine and many very fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

Bw1—3 to 10 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; few fine and many very fine roots; few faint clay films on faces of peds; dark grayish brown (2.5Y 4/2) organic stains on faces of prisms; many filaments and few medium accumulations of free carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

Bw2—10 to 18 inches; light brownish gray (2.5Y 6/2)

silty clay loam, grayish brown (2.5Y 5/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; few very fine roots; many filaments and few medium accumulations of free carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—18 to 27 inches; light yellowish brown (2.5Y 6/4) silt loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many filaments and few medium accumulations of free carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—27 to 40 inches; light yellowish brown (2.5Y 6/4) silty clay loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; many filaments and few accumulations of free carbonate; strong effervescence; moderately alkaline; smooth wavy boundary.

C3—40 to 45 inches; light yellowish brown (2.5Y 6/4) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; smooth wavy boundary.

C4—45 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline.

The A horizon has hue of 2.5Y or 10YR and value of 5 or 6. The C horizon has value of 5 to 7. It is silty clay, silty clay loam, clay loam, or silt loam and is stratified in many pedons. Coarser or finer textures are below a depth of 40 inches in some pedons.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. They are underlain by sand and gravel at a depth of about 23 inches. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 1,780 feet south and 580 feet west of the northeast corner of sec. 23, T. 153 N., R. 88 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—7 to 16 inches; light brownish gray (10YR 6/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and plastic; common very fine roots; about 10 percent gravel; many large irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—16 to 23 inches; grayish brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; few distinct strong brown (7.5YR 5/6 moist) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and plastic; few very fine roots; about 10 percent gravel; many large irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

2Bk3—23 to 34 inches; white (2.5Y 8/2) gravelly sand, grayish brown (2.5Y 5/2) moist; common distinct strong brown (7.5YR 5/6 moist) mottles; single grain; loose, nonsticky and nonplastic; few very fine roots; about 20 percent gravel; lime disseminated throughout and as a thin crust on the underside of pebbles; violent effervescence; moderately alkaline; clear wavy boundary.

2C1—34 to 48 inches; light yellowish brown (2.5Y 6/4) sand, olive brown (2.5Y 4/4) moist; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; violent effervescence; moderately alkaline; gradual wavy boundary.

2C2—48 to 60 inches; light gray (2.5Y 7/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; many distinct olive brown (2.5Y 4/4 moist) mottles; single grain; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 13 inches. The depth to sand and gravel ranges from 20 to 40 inches. Some pedons are saline.

The A horizon has value of 3 or 4. The Bk horizon has value of 4 to 7 moist. It is loam, sandy clay loam, clay loam, or gravelly loam. The 2C horizon has hue of 2.5Y or 10YR and value of 5 to 7 (4 to 6 moist). It is very gravelly sand, gravelly sand, gravelly loamy sand, loamy sand, sand, or loamy fine sand.

Farnuf Series

The Farnuf series consists of deep, well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Typical pedon of Farnuf loam, 1 to 3 percent slopes, 850 feet east and 525 feet north of the southwest corner of sec. 16, T. 156 N., R. 93 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; neutral; abrupt smooth boundary.

Bt1—5 to 13 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; many very fine roots; continuous distinct clay films on faces of peds; neutral; clear smooth boundary.

Bt2—13 to 19 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and plastic; common very fine roots; many distinct clay films on faces of peds; neutral; clear smooth boundary.

Btk—19 to 23 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; common medium distinct brownish yellow (10YR 6/8) and light brownish gray (2.5Y 6/2 moist) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and plastic; few very fine roots; few distinct clay films on faces of peds; few fine irregularly shaped soft masses of lime; slight effervescence; mildly alkaline; clear smooth boundary.

Bk1—23 to 33 inches; pale yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common fine distinct brownish yellow (10YR 6/8) and light brownish gray (2.5Y 6/2 moist) relict mottles; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and plastic; few very fine roots; many medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

Bk2—33 to 41 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; many fine distinct brownish yellow (10YR 6/8) and common fine and medium distinct light brownish gray (2.5Y 6/2 moist) relict mottles; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; common medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—41 to 49 inches; stratified pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) silty clay loam, light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) moist; many medium distinct yellowish red (5YR 5/6 moist) relict mottles; massive; hard, firm, sticky and plastic; few very fine roots; few medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—49 to 60 inches; stratified light gray (2.5Y 7/2) and reddish yellow (5YR 6/6) silty clay loam, grayish brown (2.5Y 5/2) and yellowish red (5YR 4/6) moist; massive; hard, firm, sticky and very plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to lime ranges from 11 to 25 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 2 to 4. It is clay loam, loam, or silty clay loam. Some pedons do not have a Btk horizon. The Bk horizon has hue of 2.5Y or 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is silty clay loam, clay loam, silt loam, or loam. The C horizon has hue of 2.5Y or 10YR and value of 5 to 7 (4 to 6 moist). It is silty clay loam or thinly stratified loam, silty clay loam, silt loam, very fine sandy loam, or fine sandy loam.

Flasher Series

The Flasher series consists of shallow, somewhat excessively drained, moderately rapidly permeable soils on dissected uplands. These soils formed in material weathered from soft sandstone bedrock. Slope ranges from 6 to 60 percent.

Typical pedon of Flasher loamy sand, in an area of Flasher-Vebar complex, 9 to 60 percent slopes; 2,400 feet west and 1,490 feet north of the southeast corner of sec. 24, T. 154 N., R. 92 W.

A—0 to 4 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; loose, nonsticky and nonplastic; many very fine roots;

strong effervescence; mildly alkaline; clear wavy boundary.

AC—4 to 15 inches; yellowish brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) moist; weak coarse subangular blocky structure; loose, nonsticky and nonplastic; common very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Cr—15 to 60 inches; pale yellow (2.5Y 8/4), soft sandstone bedrock, light yellowish brown (2.5Y 6/4) moist; few very fine roots in the upper few inches; strong effervescence; moderately alkaline.

The depth to sandstone bedrock is 10 to 15 inches. The A horizon has value of 4 or 5 (2 or 3 moist). The AC horizon has value of 3 or 4 when moist and chroma of 3 or 4 when dry. It is loamy sand or loamy fine sand. Some pedons have a C horizon.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, highly calcareous, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes; 1,550 feet west and 540 feet south of the northeast corner of sec. 26, T. 158 N., R. 88 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—8 to 15 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; few fine distinct brown (7.5YR 4/4 moist) mottles; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and few very fine roots; about 5 percent gravel; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—15 to 34 inches; very pale brown (10YR 7/4) loam, yellowish brown (10YR 5/4) moist; few fine distinct brown (7.5YR 4/4 moist) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; common medium irregularly shaped soft masses of lime; moderately alkaline; gradual wavy boundary.

C—34 to 60 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; about 5 percent gravel; many medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The A horizon has value of 4 or 5 (2 or 3 moist). Some pedons have an ABk horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 8 (3 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline to strongly alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. Some pedons are saline.

Harriet Series

The Harriet series consists of deep, poorly drained, alkali, slowly permeable soils on flood plains and terraces. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Harriet loam, 120 feet east and 910 feet north of the southwest corner of sec. 26, T. 152 N., R. 90 W.

E—0 to 1 inch; gray (10YR 6/1) loam, very dark gray (10YR 3/1) moist; weak very thin platy structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bt—1 to 4 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong medium columnar structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; common very fine and fine roots; many distinct clay films on faces of peds and lining pores; gray (10YR 6/1) silt coatings on the top of columns; strong effervescence; moderately alkaline; clear smooth boundary.

Bkyz1—4 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; few fine nests of salts; few nests of gypsum;

common filaments and fine irregularly shaped soft masses of lime; violent effervescence; strongly alkaline; clear wavy boundary.

Bkyz2—10 to 17 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; few fine distinct gray (5Y 5/1 moist) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; few fine roots; dark brown (10YR 4/3) coatings on faces of peds; few fine nests of salts; few nests of gypsum; common filaments and fine irregularly shaped soft masses of lime; violent effervescence; strongly alkaline; gradual wavy boundary.

BCkyz—17 to 45 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; few fine distinct gray (5Y 5/1) mottles; massive; very hard, firm, sticky and plastic; few fine roots; dark brown (10YR 4/3) coatings on faces of peds; few fine nests of salts; few nests of gypsum; few filaments and fine and medium irregularly shaped soft masses of lime; violent effervescence; very strongly alkaline; gradual wavy boundary.

C1—45 to 50 inches; light brownish gray (2.5Y 6/2), stratified clay loam and sandy loam, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, sticky and plastic; common fine nests of salts; few nests of gypsum; strong effervescence; strongly alkaline; gradual wavy boundary.

C2—50 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; very hard, firm, sticky and plastic; many fine nests of salts; few nests of gypsum; strong effervescence; strongly alkaline.

Some pedons have a thin A horizon. The E horizon has value of 6 or 7 (3 to 5 moist). The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is clay loam, silty clay, or silty clay loam. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1 to 3. It is clay loam, loam, silty clay loam, silty clay, sandy loam, or sandy clay loam.

Korchea Series

The Korchea series consists of deep, well drained, moderately permeable soils on flood plains and terraces. These soils formed in alluvium. Slope ranges from 0 to 3 percent.

The Korchea soils in this county contain slightly less clay in the substratum than is definitive for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Korchea loam, in an area of Korchea and Straw loams, 0 to 3 percent slopes; 2,400 feet east and 1,250 feet south of the northwest corner of sec. 22, T. 156 N., R. 94 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium and coarse roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—6 to 12 inches; grayish brown (2.5Y 5/2), stratified loam and silt loam, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium and coarse roots; disseminated lime throughout; slight effervescence; mildly alkaline; clear wavy boundary.

C2—12 to 25 inches; light brownish gray (2.5Y 6/2), stratified silt loam and loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium and coarse roots; disseminated lime throughout; strong effervescence; moderately alkaline; abrupt wavy boundary.

C3—25 to 28 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; loose, slightly sticky and nonplastic; common very fine and fine and few medium and coarse roots; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C4—28 to 45 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; few coarse roots; disseminated lime throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C5—45 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, olive brown (2.5Y 4/4) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, sticky and plastic; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

Some pedons have an Ab horizon. The A horizon has value of 3 or 4 (2 or 3 moist). The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4.

Lehr Series

The Lehr series consists of deep, somewhat excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. They are underlain by sand and gravel at a depth of about 15 inches. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Lehr loam, 1 to 6 percent slopes, 625 feet west and 1,490 feet north of the southeast corner of sec. 12, T. 156 N., R. 93 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw—6 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; mildly alkaline; gradual wavy boundary.

Bk1—11 to 15 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few distinct very dark grayish brown (10YR 3/2 moist) coatings on faces of peds; about 10 percent gravel; common filaments and medium irregularly shaped soft masses of lime; thin crust of lime on the underside of pebbles; violent effervescence; moderately alkaline; clear smooth boundary.

2Bk2—15 to 22 inches; light yellowish brown (10YR 6/4) and white (10YR 8/1) gravelly loamy coarse sand, yellowish brown (10YR 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; about 30 percent gravel; many filaments and medium irregularly shaped soft masses of lime; thin crust of lime on the underside of pebbles; violent effervescence; moderately alkaline; clear smooth boundary.

2C—22 to 60 inches; light brownish gray (2.5Y 6/2) and pale yellow (2.5Y 7/4) very gravelly coarse sand, grayish brown (2.5Y 5/2) and light yellowish brown (2.5Y 6/4) moist; single grain; loose, nonsticky and nonplastic; about 40 percent gravel; thin crust of lime on the underside of pebbles; strong effervescence; moderately alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The thickness of the mollic epipedon ranges from 7 to 14 inches. The depth to lime is 11 to 15 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 or 3. It is loam or sandy clay loam in which the content of gravel is 1 to 10 percent. The Bk1 horizon has hue of 10YR or 2.5Y, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It has 2 to 15 percent gravel. Some pedons do not have a Bk1 horizon. The 2Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 to 4. It is gravelly loamy sand, gravelly loamy coarse sand, or very gravelly loamy coarse sand. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4.

Lihen Series

The Lihen series consists of deep, well drained soils on lake plains and mantled till plains. These soils formed in glaciolacustrine deposits, glacial till, and eolian deposits. Permeability is either rapid throughout the profile or rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 9 percent.

Typical pedon of Lihen loamy sand, loamy substratum, 1 to 6 percent slopes, 2,420 feet east and 140 feet north of the southwest corner of sec. 3, T. 152 N., R. 90 W.

Ap—0 to 6 inches; brown (10YR 4/3) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; mildly alkaline; clear smooth boundary.

A1—6 to 12 inches; brown (10YR 4/3) loamy sand, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and common fine roots; mildly alkaline; clear smooth boundary.

A2—12 to 20 inches; very dark grayish brown (10YR 3/2) loamy sand, very dark brown (10YR 2/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common very

fine and fine roots; mildly alkaline; clear wavy boundary.

AC—20 to 30 inches; brown (10YR 5/3) sand, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; soft, loose, nonsticky and nonplastic; few very fine roots; mildly alkaline; abrupt wavy boundary.

C1—30 to 51 inches; light brownish gray (2.5Y 6/2) sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—51 to 58 inches; light yellowish brown (2.5Y 6/4) fine sand, olive brown (2.5Y 4/4) moist; single grain; loose, nonsticky and nonplastic; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

2C3—58 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm, sticky and plastic; few pebbles; common filaments of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 12 to 30 inches. The depth to lime ranges from 13 to 31 inches. Depth to the 2C horizon is 41 inches or more. Some pedons have a buried A horizon.

The Ap horizon is sandy loam or loamy sand. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is sand, loamy sand, or loamy fine sand. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is sand, fine sand, loamy sand, or loamy fine sand. The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4. It is clay loam, loam, sandy loam, or silty clay loam. Some pedons do not have a 2C horizon.

Livona Series

The Livona series consists of deep, well drained, moderately slowly permeable soils on mantled till plains and on lake plains. These soils formed in eolian deposits and glacial till. Slope ranges from 1 to 6 percent.

Typical pedon of Livona sandy loam, 1 to 6 percent slopes, 2,000 feet south and 675 feet west of the northeast corner of sec. 21, T. 151 N., R. 93 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable, slightly sticky and nonplastic; many very fine and common fine roots; neutral; clear smooth boundary.

Bw—6 to 10 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; neutral; clear wavy boundary.

Bt1—10 to 19 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and slightly plastic; common very fine and fine roots; common distinct clay films on faces of peds; neutral; clear wavy boundary.

2Bt2—19 to 23 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct strong brown (7.5YR 4/6 moist) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; few fine roots; common distinct clay films on faces of peds; about 2 percent gravel; neutral; clear wavy boundary.

2Btk—23 to 30 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; few fine distinct strong brown (7.5YR 4/6 moist) mottles; moderate medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few fine roots; few prominent clay films on faces of peds; about 2 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

2Bk—30 to 36 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; about 3 percent gravel; lime disseminated throughout and in common fine and medium irregularly shaped soft masses; violent effervescence; moderately alkaline; gradual wavy boundary.

2C—36 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky and plastic; about 3 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 11 inches. The depth to lime ranges from 15 to 23 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The

Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 to 4. It is sandy loam or fine sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4. It is sandy clay loam, clay loam, or loam. Some pedons do not have a 2Bt horizon. Some do not have a 2Btk horizon. The 2Bk horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 to 4. Some pedons do not have a 2Bk horizon. The 2C horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 to 4.

Makoti Series

The Makoti series consists of deep, moderately well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 1 to 3 percent.

Typical pedon of Makoti silty clay loam, 1 to 3 percent slopes, 100 feet north and 1,900 feet east of the southwest corner of sec. 15, T. 151 N., R. 88 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

Bw1—6 to 12 inches; dark grayish brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; black (10YR 2/1 moist) coatings on faces of peds; neutral; gradual wavy boundary.

Bw2—12 to 20 inches; dark grayish brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; very dark brown (10YR 2/2 moist) coatings on faces of peds; many distinct clay films on faces of peds; neutral; gradual wavy boundary.

Bk1—20 to 25 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk2—25 to 32 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct light gray (10YR 6/1) and common fine faint light olive brown (2.5Y 5/4 moist) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; lime disseminated throughout and in many fine irregularly shaped soft masses; violent effervescence; mildly alkaline; gradual wavy boundary.

C—32 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common medium distinct yellowish brown (10YR 5/6 moist) mottles; massive; slightly hard, friable, sticky and plastic; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 23 inches. The depth to lime ranges from 18 to 23 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4. The Bk horizon has hue of 2.5Y or 10YR, value of 5 or 6 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam, silt loam, or clay loam. Some pedons do not have a Bk horizon but have a BCk horizon. The C horizon has hue of 5Y, 2.5Y, or 10YR, value of 6 or 7 (4 or 5 moist), and chroma of 2 to 4. It has few to many mottles. It is loam, silt loam, clay loam, or silty clay loam.

Manning Series

The Manning series consists of deep, somewhat excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. They are underlain by sand and gravel at a depth of about 23 inches. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Manning sandy loam, 1 to 6 percent slopes, 550 feet west and 2,450 feet north of the southeast corner of sec. 20, T. 155 N., R. 89 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to moderate very fine granular; soft, very friable, nonsticky and nonplastic; about 2 percent gravel; common very fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 12 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, nonsticky and nonplastic; about 5

percent gravel; common very fine roots; neutral; clear smooth boundary.

Bw2—12 to 15 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, nonsticky and nonplastic; about 10 percent gravel; common very fine roots; mildly alkaline; clear smooth boundary.

Bk—15 to 23 inches; very pale brown (10YR 8/3) and pale brown (10YR 6/3) sandy loam, pale brown (10YR 6/3) and brown (10YR 4/3) moist; weak very coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; about 10 percent gravel; few very fine roots; lime disseminated throughout and in many fine irregularly shaped soft masses; violent effervescence; moderately alkaline; clear smooth boundary.

2C—23 to 60 inches; light yellowish brown (10YR 6/4) very gravelly sand, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; about 45 percent gravel; disseminated lime throughout; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 8 to 15 inches. The depth to lime is 16 to 17 inches. The depth to sand and gravel ranges from 20 to 35 inches.

The A horizon has value of 3 or 4. The Bw horizon has value of 4 to 6 (3 or 4 moist) and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 (4 to 6 moist), and chroma of 2 or 3. It has 5 to 15 percent gravel. The 2C horizon is gravelly sand, very gravelly sand, or extremely gravelly sand.

Max Series

The Max series consists of deep, well drained, moderately slowly permeable soils on moraines and truncated till plains. These soils formed in glacial till. Slope ranges from 25 to 35 percent.

Typical pedon of Max loam, in an area of Zahl-Max loams, 25 to 60 percent slopes; 200 feet west and 425 feet north of the southeast corner of sec. 10, T. 153 N., R. 92 W.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; about 3 percent gravel; many very fine and few fine roots; mildly alkaline; clear smooth boundary.

Bw—7 to 15 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; about 3 percent gravel; common very fine roots; slight effervescence in the lower part; mildly alkaline; clear smooth boundary.

Bk1—15 to 27 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm, sticky and plastic; about 5 percent gravel; few very fine roots; lime disseminated throughout and in common fine irregularly shaped masses; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—27 to 38 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; about 5 percent gravel; few very fine roots; lime disseminated throughout and in few fine irregularly shaped soft masses; strong effervescence; moderately alkaline; gradual wavy boundary.

C—38 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm, sticky and plastic; about 5 percent gravel; disseminated lime throughout; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to lime ranges from 10 to 16 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5Y and chroma of 2 to 4. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 2 to 4.

Miranda Series

The Miranda series consists of deep, moderately well drained, alkali, very slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 1 to 9 percent.

Typical pedon of Miranda loam, in an area of Miranda-Noonan loams, 1 to 6 percent slopes; 1,400 feet north and 2,450 feet west of the southeast corner of sec. 33, T. 157 N., R. 91 W.

E—0 to 2 inches; light brownish gray (10YR 6/2) loam,

very dark grayish brown (10YR 3/2) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; neutral; abrupt wavy boundary.

Bt—2 to 5 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; strong medium columnar structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; common very fine and fine and few medium roots, confined to faces of peds; light brownish gray (10YR 6/2) silt coatings on the top of columns; common distinct clay films on faces of peds; mildly alkaline; clear smooth boundary.

Btk—5 to 10 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine angular blocky; very hard, firm, very sticky and very plastic; common very fine and few medium roots; many distinct clay films on faces of peds; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Btkz—10 to 18 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, sticky and plastic; few very fine and fine roots; many faint clay films on faces of peds; many fine and medium nests of salts; few medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—18 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct dark yellowish brown (10YR 4/6 moist) mottles; massive; slightly hard, friable, sticky and plastic; common medium nests of salts; few filaments and medium irregularly shaped soft masses of lime; strong effervescence; strongly alkaline.

The depth to salts ranges from 6 to 14 inches. The depth to lime is 5 to 8 inches.

Some pedons have a thin A horizon. The E horizon has value of 5 or 6 and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 4 moist), and chroma of 2 to 4. Some pedons have a Bkz or Bky horizon. The C horizon has value of 5 or 6 (3 to 5 moist). It is clay loam or loam.

Noonan Series

The Noonan series consists of deep, moderately well drained, alkali, slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 1 to 6 percent.

Typical pedon of Noonan loam, in an area of Noonan-Williams loams, 1 to 6 percent slopes; 215 feet south and 2,290 feet east of the northwest corner of sec. 21, T. 151 N., R. 89 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

E—6 to 10 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to moderate thin platy; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; slightly acid; clear wavy boundary.

Bt1—10 to 15 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong coarse columnar structure parting to moderate fine and very fine angular blocky; very hard, very firm, sticky and plastic; common very fine roots, confined to faces of peds; very dark brown (10YR 2/2 moist) coatings on faces of peds; light brownish gray (10YR 6/2) silt coatings on the top of columns; many faint clay films on faces of peds and lining pores; neutral; clear wavy boundary.

Bt2—15 to 19 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots, confined to faces of peds; very dark grayish brown (10YR 3/2 moist) coatings on faces of peds; many faint clay films on faces of peds and lining pores; about 2 percent gravel; mildly alkaline; clear wavy boundary.

Bkyz—19 to 26 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; many nests of salts and gypsum; lime disseminated throughout and in common fine rounded soft masses; strong effervescence; mildly alkaline; clear wavy boundary.

Bky—26 to 47 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; about 5 percent gravel; common nests of gypsum; lime disseminated throughout and

in many fine rounded soft masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C—47 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few medium faint gray (N 6/0 moist) mottles; massive; hard, firm, sticky and plastic; about 5 percent gravel; disseminated lime throughout; strong effervescence; moderately alkaline.

The A horizon has value of 3 or 4. The E horizon has value of 5 to 7 (3 or 4 moist) and chroma of 1 or 2. It is loam or silt loam. Some pedons do not have an E horizon. The Bt horizon has value of 3 to 5 (2 to 4 moist). Some pedons have a Btz horizon. Some have a Btk horizon. The Bky horizon has hue of 2.5Y or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. Some pedons have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 or 3.

Nutley Series

The Nutley series consists of deep, well drained, slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Typical pedon of Nutley silty clay, 1 to 3 percent slopes, 1,750 feet east and 710 feet north of the southwest corner of sec. 26, T. 157 N., R. 88 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bw1—5 to 9 inches; grayish brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; very dark gray (10YR 3/1 moist) tongues of the A horizon ½ to 1 inch wide; slight effervescence; mildly alkaline; clear wavy boundary.

Bw2—9 to 26 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; very hard, very firm, sticky and plastic; few very fine roots; very dark gray (10YR 3/1 moist) tongues of the A horizon in the upper part; strong effervescence; mildly alkaline; clear wavy boundary.

BC—26 to 36 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, very firm, very sticky and very plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; light olive gray (5Y 6/2) clay, olive gray (5Y 5/2) moist; massive; extremely hard, very firm, very sticky and very plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to lime ranges from 0 to 10 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bw horizon has hue of 2.5Y or 10YR and value of 4 to 6. It is silty clay or clay. Some pedons have a Bk horizon. The C horizon has hue of 2.5Y or 5Y, value of 6 or 7 (4 or 5 moist), and chroma of 2 to 4. In some pedons it is mottled throughout. It is clay, silty clay, or silty clay loam and in some pedons is stratified. It has gypsum in some pedons.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on till plains, moraines, and lake plains. These soils formed in glacial till, glaciolacustrine deposits, and alluvium. Slope is 0 to 1 percent.

Typical pedon of Parnell silt loam, 500 feet north and 50 feet west of the southeast corner of sec. 21, T. 154 N., R. 93 W.

Oi—1 inch to 0; roots and partly decomposed stems and leaves; abrupt smooth boundary.

A1—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; few fine distinct strong brown (7.5YR 5/6 moist) mottles; weak thin platy structure; soft, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; slightly acid; clear wavy boundary.

A2—8 to 11 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; few fine distinct strong brown (7.5YR 5/6 moist) mottles; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; neutral; gradual smooth boundary.

Bt—11 to 30 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; moderate medium prismatic structure parting to strong fine subangular blocky; hard, firm, sticky and plastic; many medium and fine

roots; many distinct clay films on faces of peds and lining pores; about 1 percent gravel; neutral; gradual wavy boundary.

BC—30 to 60 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; few fine distinct very dark grayish brown (2.5Y 3/2 moist) mottles; weak fine prismatic structure; hard, firm, sticky and plastic; common faint clay films on faces of peds and lining pores; very few medium and fine roots; neutral.

The depth to lime ranges from 35 to more than 60 inches. Some pedons have an E horizon, which is 1 to 4 inches thick.

The Bt horizon has hue of 10YR to 5Y and value of 3 to 5 (2 to 4 moist). It is clay or silty clay. Some pedons do not have a BC horizon. Some have a C horizon.

Parshall Series

The Parshall series consists of deep, well drained, moderately rapidly permeable soils on outwash plains and lake plains. These soils formed in alluvium. Slope ranges from 1 to 6 percent.

Typical pedon of Parshall sandy loam, 1 to 6 percent slopes, 1,800 feet north and 2,100 feet west of the southeast corner of sec. 18, T. 152 N., R. 89 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw—6 to 21 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

Bk—21 to 33 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of lime; violent effervescence; mildly alkaline; clear wavy boundary.

C1—33 to 41 inches; light yellowish brown (2.5Y 6/4) loamy sand, light olive brown (2.5Y 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; disseminated lime throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C2—41 to 60 inches; olive yellow (2.5Y 6/6) and light yellowish brown (2.5Y 6/4), stratified loamy sand, sandy loam, and loam, light olive brown (2.5Y 5/6 and 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common filaments of lime; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 29 inches. The depth to lime ranges from 21 to 29 inches.

The A horizon has value of 3 or 4. The Bw horizon has value of 2 or 3 when moist and chroma of 2 or 3 when dry. It is sandy loam or fine sandy loam. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is sandy loam, fine sandy loam, or loamy fine sand. The C horizon has value of 6 or 7 and chroma of 2 to 6.

Rhoades Series

The Rhoades series consists of deep, moderately well drained, alkali, very slowly permeable soils on terraces, fans, and dissected uplands. These soils formed in alluvium and material weathered from soft bedrock. Slope ranges from 1 to 15 percent.

Typical pedon of Rhoades loam, in an area of Rhoades-Cabba loams, 3 to 25 percent slopes; 1,110 feet north and 2,360 feet east of the southwest corner of sec. 18, T. 150 N., R. 92 W.

E—0 to 3 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; slightly acid; clear smooth boundary.

Bt—3 to 11 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong medium columnar structure parting to moderate medium and fine angular blocky; very hard, very firm, sticky and plastic; many very fine roots, confined to faces of peds; many distinct clay films on faces of peds and lining pores; neutral; clear smooth boundary.

Btz—11 to 15 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard, very firm, sticky and plastic; common very fine roots, confined to faces of peds; many faint clay films on faces of peds and lining pores; few fine nests of salts; few filaments and fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

Bz—15 to 25 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, firm, sticky and plastic; few very fine roots; many fine nests of salts; few filaments and fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

BC—25 to 32 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, firm, sticky and slightly plastic; few very fine roots; common fine nests of salts; few filaments and fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline.

The depth to salts or gypsum ranges from 5 to 12 inches. The E horizon has value of 5 or 6 (2 to 4 moist). The Bt horizon has value of 3 to 5 (2 to 4 moist) and chroma of 2 or 3. It is silty clay, clay, or clay loam. The Bz horizon has hue of 2.5Y or 10YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. It is clay loam, silty clay loam, or loam. Some pedons have a Bk, By, or BCy horizon. The C horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 to 4. It is silty clay, silty clay loam, loam, or clay loam. Some pedons have soft bedrock at a depth of 40 to 60 inches.

Sakakawea Series

The Sakakawea series consists of deep, well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 3 to 9 percent.

Typical pedon of Sakakawea loam, 3 to 9 percent slopes, 1,500 feet south and 2,425 feet west of the northeast corner of sec. 23, T. 158 N., R. 93 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—6 to 14 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and plastic; few very fine roots; many fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—14 to 21 inches; light yellowish brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; weak medium prismatic structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C1—21 to 29 inches; stratified light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) silt loam, grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) moist; few fine prominent strong brown (7.5YR 5/6 moist) relict mottles; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; few filaments of lime; strong effervescence; moderately alkaline; abrupt smooth boundary.

C2—29 to 41 inches; stratified light brownish gray (2.5Y 6/2) and pale yellow (2.5Y 7/4) loam, grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) moist; few fine prominent strong brown (7.5YR 5/6 moist) relict mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; disseminated lime throughout; strong effervescence; moderately alkaline; abrupt smooth boundary.

C3—41 to 60 inches; stratified light brownish gray (2.5Y 6/2) silty clay loam and pale yellow (2.5Y 7/4) loamy sand, grayish brown (2.5Y 5/2) and light yellowish brown (2.5Y 6/4) moist; few fine prominent strong brown (7.5YR 5/6 moist) relict mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; disseminated lime throughout; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 9 inches thick. The depth to lime ranges from 0 to 5 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 2 or 3. Some pedons have an ABk or Bw horizon. The Bk horizon has value of 5 to 8 (4 to 6 moist) and chroma of 2 to 4. The C horizon has value of 5 to 8 (4 to 6 moist) and chroma of 2 to 4. It is loam or silt loam in the upper part and silty clay, silty clay loam, silt loam, loam, fine sandy loam, loamy fine sand, or loamy sand in the lower part. Some pedons do not have mottles. A few pedons have gypsum in the C horizon.

Savage Series

The Savage series consists of deep, well drained, slowly permeable soils on fans and terraces. These soils formed in alluvium. Slope ranges from 1 to 6 percent.

Typical pedon of Savage silty clay loam, 1 to 6 percent slopes, 1,680 feet south and 2,070 feet east of the northwest corner of sec. 34, T. 154 N., R. 92 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; neutral; abrupt smooth boundary.

Bt1—5 to 12 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots; many distinct clay films on faces of peds; neutral; clear wavy boundary.

Bt2—12 to 16 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots; many distinct clay films on faces of peds and lining pores; mildly alkaline; clear wavy boundary.

Btk—16 to 34 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; few faint clay films on faces of peds; lime disseminated throughout and in common filaments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk—34 to 48 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—48 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 12 to 16 inches. The depth to lime ranges from 13 to 22 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). The Bt horizon has value of 3 to 5 (2 to 4 moist) and chroma of 2 or 3. It is silty clay or silty clay loam. The Bk horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 2 to 4. It is silty clay or silty clay loam. Some pedons do not have a Bk horizon. Some have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is clay loam, silty clay loam, or silty clay.

Shambo Series

The Shambo series consists of deep, well drained, moderately permeable soils on dissected uplands, fans, and terraces. These soils formed in alluvium. Slope ranges from 1 to 15 percent.

Typical pedon of Shambo loam, 1 to 6 percent slopes, 90 feet south and 600 feet east of the northwest corner of sec. 24, T. 151 N., R. 91 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

Bw1—5 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few distinct clay films on faces of peds; neutral; clear wavy boundary.

Bw2—10 to 15 inches; brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; few faint clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bk—15 to 47 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; many fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—47 to 60 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to lime ranges from 11 to 18 inches. Some pedons have an Ab horizon.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam or clay loam. The Bw horizon has value of 4 or 5 (3 or 4 moist). It is loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is loam, clay loam, or silt loam. The C horizon has hue of 2.5Y or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam, clay loam, or silty clay loam. Some pedons have soft bedrock at a depth of 40 to 60 inches.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on till plains, moraines, and lake plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silty clay loam, 700 feet north and 400 feet east of the southwest corner of sec. 23, T. 155 N., R. 88 W.

Ag1—0 to 3 inches; very dark gray (N 3/0) silty clay loam, black (N 2/0) moist; weak fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ag2—3 to 9 inches; very dark gray (5Y 3/1) silty clay loam, black (5Y 2/1) moist; weak fine angular blocky structure; very hard, firm, sticky and very plastic; common very fine and few fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

Ag3—9 to 14 inches; dark olive gray (5Y 3/2) silty clay, black (5Y 2/2) moist; massive; very hard, very firm, very sticky and very plastic; few fine roots; many fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

Ag4—14 to 24 inches; dark olive gray (5Y 3/2) silty clay, black (5Y 2/2) moist; massive; very hard, very firm, very sticky and very plastic; common fine snail shell fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

Cg1—24 to 40 inches; olive gray (5Y 4/2) silty clay, dark olive gray (5Y 3/2) moist; massive; extremely hard, extremely firm, very sticky and very plastic; common fine snail shell fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2—40 to 60 inches; olive gray (5Y 5/2) clay, dark olive gray (5Y 3/2) moist; massive; extremely hard, extremely firm, very sticky and very plastic; few fine snail shell fragments; strong effervescence; moderately alkaline.

Some pedons have an O horizon, which is as much as 4 inches thick. The A horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 or 4 (2 or 3 moist). The C horizon has hue of 2.5Y or 5Y or is neutral in hue. It has chroma of 1 or 2. In some pedons it has distinct or prominent mottles.

Straw Series

The Straw series consists of deep, well drained, moderately permeable soils on flood plains and terraces. These soils formed in alluvium. Slope ranges from 0 to 3 percent.

Typical pedon of Straw loam, in an area of Korchea and Straw loams, 0 to 3 percent slopes; 1,900 feet west and 800 feet south of the northeast corner of sec. 27, T. 156 N., R. 94 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium and coarse roots; mildly alkaline; clear smooth boundary.

A2—3 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium and coarse roots; disseminated lime throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

A3—13 to 26 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine and few medium and coarse roots; disseminated lime throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

C—26 to 38 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Ab—38 to 41 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C′—41 to 60 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to lime is 3 to 7 inches.

The C horizon has value of 5 to 7 (3 to 5 moist) and chroma of 2 to 4. It is dominantly loam, clay loam, silt loam, or silty clay loam. In some pedons, however, it has strata of sandy loam or loamy sand. Some pedons do not have an Ab horizon.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on till plains, moraines, and lake plains. These soils formed in glacial till, glaciolacustrine deposits, and alluvium. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, 1,860 feet west and 190 feet north of the southeast corner of sec. 22, T. 158 N., R. 88 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; medium acid; abrupt smooth boundary.

E—8 to 14 inches; gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; many fine prominent dark reddish brown (5YR 3/3 moist) mottles; moderate medium subangular blocky structure parting to moderate thin platy; soft, very friable, slightly sticky and slightly plastic; few coarse and common fine roots; medium acid; clear smooth boundary.

Bt—14 to 35 inches; dark grayish brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; many fine prominent yellowish red (5YR 5/8 moist) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few fine and coarse roots; common distinct clay films on faces of peds; medium acid; clear wavy boundary.

BC—35 to 42 inches; dark grayish brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; many fine prominent yellowish red (5YR 5/8 moist) mottles; massive; hard, firm, sticky and plastic; medium acid; clear wavy boundary.

C—42 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; many fine prominent yellowish red (5YR 5/8 moist) mottles; massive; hard, firm, sticky and plastic; neutral.

The depth to lime ranges from 31 to more than 60 inches. The A horizon has value of 3 to 5. The E horizon has value of 5 to 7 (3 or 4 moist). It is silt loam, loam, or very fine sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is clay loam, silty clay loam, silty clay, or clay. Some pedons have a Bk horizon. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is clay loam or loam. In some pedons it has 10 to 20 percent gravel.

Vallers Series

The Vallers series consists of deep, poorly drained, saline, highly calcareous, moderately slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Vallers loam, saline, 100 feet east and 1,700 feet north of the southwest corner of sec. 15, T. 152 N., R. 88 W.

Az1—0 to 2 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; common fine nests of salts; slight effervescence; mildly alkaline; clear smooth boundary.

Az2—2 to 6 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine and very fine and common medium roots; few fine nests of salts; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—6 to 28 inches; white (5Y 8/1) loam, gray (5Y 6/1) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—28 to 57 inches; gray (5Y 5/1) loam, dark gray

(5Y 4/1) moist; few medium prominent strong brown (7.5YR 5/8 moist) mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; about 2 percent gravel; lime disseminated throughout and in common fine irregularly shaped soft masses; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg2—57 to 60 inches; light olive gray (5Y 6/2) coarse sandy loam, olive gray (5Y 5/2) moist; many large distinct yellow (2.5Y 7/6) mottles; massive; soft, very friable, nonsticky and nonplastic; about 5 percent gravel; many large manganese coatings; lime disseminated throughout and in few fine irregularly shaped soft masses; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR to 5Y and value of 3 to 5 (2 or 3 moist). The Bkg horizon has hue of 2.5Y or 5Y, value of 5 to 8 (4 to 6 moist), and chroma of 1 or 2. It is loam or clay loam. The Cg horizon has value of 5 to 7 (4 to 6 moist) and chroma of 1 to 3. It is loam or clay loam. The 2Cg horizon has hue of 2.5Y or 5Y and value of 6 or 7. It is coarse sandy loam or very gravelly sand.

Vebar Series

The Vebar series consists of moderately deep, well drained, moderately rapidly permeable soils on dissected uplands. These soils formed in material weathered from soft sandstone bedrock. Slope ranges from 6 to 15 percent.

Typical pedon of Vebar sandy loam, in an area of Vebar-Flasher-Zahl complex, 6 to 25 percent slopes; 2,500 feet west and 650 feet north of the southeast corner of sec. 30, T. 151 N., R. 88 W.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; many very fine and few fine roots; slightly acid; clear smooth boundary.

Bw1—6 to 10 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; slightly acid; gradual wavy boundary.

Bw2—10 to 15 inches; dark yellowish brown (10YR 4/4) sandy loam, dark yellowish brown (10YR 3/4) moist; moderate coarse prismatic structure parting to weak and moderate fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; neutral; clear wavy boundary.

Bw3—15 to 24 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; moderate coarse prismatic structure parting to weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

Cr—24 to 60 inches; light yellowish brown (2.5Y 6/4), soft sandstone, light olive brown (2.5Y 5/4) moist; strong effervescence; moderately alkaline.

The A horizon has value of 3 or 4. The Bw horizon has chroma of 2 to 4. It is sandy loam or fine sandy loam. Some pedons have a Bk horizon. The Cr horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 to 4.

Wabek Series

The Wabek series consists of deep, excessively drained, very rapidly permeable soils on collapsed outwash plains and on terraces. These soils formed in glaciofluvial deposits. They are underlain by sand and gravel at a depth of about 12 inches. Slope ranges from 1 to 35 percent.

Typical pedon of Wabek loam, 1 to 35 percent slopes, 25 feet west and 200 feet north of the southeast corner of sec. 13, T. 152 N., R. 91 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 10 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

2Bk—6 to 12 inches; grayish brown (10YR 5/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to moderate fine subangular blocky; soft, friable, slightly sticky and nonplastic; few very fine roots; about 20 percent gravel; many fine rounded segregated soft masses of lime; thin crust of lime on the underside of pebbles; violent effervescence; moderately alkaline; clear wavy boundary.

2C—12 to 60 inches; light brownish gray (10YR 6/2) very gravelly coarse sand, dark grayish brown (10YR 4/2) moist; single grain; loose, nonsticky and nonplastic; about 45 percent gravel; violent effervescence; moderately alkaline.

The depth to sand and gravel ranges from 8 to 13 inches. The depth to lime ranges from 0 to 8 inches. The thickness of the mollic epipedon ranges from 7 to 13 inches.

The A horizon has value of 2 or 3 moist. The 2Bk horizon has hue of 10YR or 2.5Y, value of 4 to 7 (2 to 6 moist), and chroma of 2 to 4. It is gravelly coarse sandy loam or gravelly loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4.

Williams Series

The Williams series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 1 to 25 percent.

Typical pedon of Williams loam, in an area of Williams-Zahl loams, 3 to 6 percent slopes; 1,050 feet east and 60 feet south of the northwest corner of sec. 5, T. 158 N., R. 94 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few pebbles; neutral; abrupt smooth boundary.

Bt1—6 to 10 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; strong medium prismatic structure parting to strong medium angular blocky; hard, firm, sticky and plastic; common very fine roots; many distinct clay films on faces of peds and lining pores; few pebbles; neutral; clear wavy boundary.

Bt2—10 to 15 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to strong medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; many distinct clay films on faces of peds and lining pores; mildly alkaline; clear wavy boundary.

Btk—15 to 24 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common very fine roots; few faint clay films on faces of peds; few pebbles; common medium irregularly shaped soft masses of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

Bk—24 to 36 inches; light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; soft, friable, sticky and plastic; few very fine roots; few cobbles; lime disseminated throughout and in common irregularly shaped soft masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; few fine prominent yellowish brown (10YR 5/6) and light gray (10YR 7/2 moist) mottles; massive; soft, friable, sticky and plastic; few pebbles and cobbles; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to lime ranges from 10 to 16 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). The Bt horizon has value of 4 to 6 (2 to 4 moist). The Bk horizon has hue of 2.5Y or 10YR, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. Some pedons have a BC horizon. The C horizon has hue of 2.5Y, 10YR, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is clay loam or loam.

Zahl Series

The Zahl series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 60 percent.

Typical pedon of Zahl loam, in an area of Zahl-Williams loams, 9 to 25 percent slopes; 25 feet south and 2,335 feet east of the northwest corner of sec. 14, T. 156 N., R. 90 W.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine pores; strong effervescence; mildly alkaline; clear wavy boundary.

Bk—5 to 20 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak medium and fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; many fine pores; few pebbles; many irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—20 to 60 inches; light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/4) clay loam, olive

brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) moist; common fine faint olive gray (5Y 5/2) and distinct gray (5Y 5/1 moist) mottles; weak medium and fine subangular blocky structure; soft, friable, sticky and plastic; few very fine roots to a depth of about 40 inches; few pebbles; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 8 (4 to 7 moist), and chroma of 2 to 4. It is loam or clay loam. Some pedons have a BCk horizon. The C horizon has hue of 2.5Y or 5Y and value of 4 to 6 moist. It is loam or clay loam.

Formation of the Soils

Soil forms through the physical and chemical weathering of deposited or accumulated geologic material. Soil characteristics are determined by the physical traits and chemical and mineralogical composition of the parent material, the climate under which the soil formed and has existed since formation, the plant and animal life on and in the soil, the relief, and the length of time that the processes of soil formation have acted on the soil material.

Climate and plant and animal life, mainly plants, are very influential factors of soil formation. They determine the nature of weathering and slowly change the parent material into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief and the parent material. Finally, time is needed for the climatic and biological forces to weather the parent material and form a soil. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Texture is one of the most important physical properties of the parent material because it determines the texture of most soils. Other properties of the parent material can also be important. For example, soils that contain excess sodium salts generally formed in material that also contains excess sodium salts.

The parent material in Mountrail County has several different origins. The most extensive parent material is glacial till. The till is preglacial rock that was picked up by the continental ice sheets and was ground, mixed, and transported many miles from its place of origin. As the ice receded, it deposited this ground and mixed rock. Williams and Zahl soils formed in this unsorted glacial till. Tonka and Parnell are examples of soils that formed in material deposited in swales and depressions created by glaciers. Farnuf and Nutley are examples of soils that formed in material sorted by water and deposited in glacial lakes. Bowdle, Lehr, and Manning are examples of soils that formed in material deposited by water flowing from glaciers. Lihen and Livona are examples of soils that formed in material sorted by wind and water. Harriet, Korchea, and Straw are examples of soils deposited by the floodwater of streams. These soils are stratified and are subject to flooding.

Cabba and Flasher soils formed in material weathered from soft bedrock of the Tertiary Period. The Fort Union Group consists of three closely related formations. Only the upper two, the Sentinel Butte Formation and the Tongue River Formation, are at the surface in Mountrail County. The Fort Union Formation occurs as strata of soft sandstone, siltstone, shale, and lignite. It is exposed on the Missouri River breaks and in the river and stream valleys that have been cut through this formation. Flasher soils formed in material weathered from soft sandstone, and Cabba soils formed in material weathered from siltstone and shale.

Climate

Climate is perhaps the most influential factor of soil formation. It affects the physical and chemical processes of soil weathering and the biological activities in the soil. The processes of soil formation are most active if the climate is warm and moist. Climate influences these processes to a large extent through its effect on vegetation.

Mountrail County has a continental, semiarid climate characterized by long, cold winters and short, warm summers. Most of the precipitation falls during the growing season. This type of climate favors the growth of mid and short grasses.

Moisture and temperature directly affect the weathering processes in the parent material. They also affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil profile. Freezing and thawing help to break down soil particles in the parent material, thereby

providing more surface area for chemical processes. The cold and semiarid climate prevents deep leaching and extensive chemical weathering. It prevents large yields of vegetation, but it allows a slow rate of plant decay and thus the accumulation of organic matter in the soil.

Plant and Animal Life

Plants have significantly influenced the formation of soils in Mountrail County. Earthworms, small animals, and micro-organisms also are important but to a lesser extent.

The native vegetation consisted mostly of mid and short grasses. Plant roots act, both physically and chemically, as agents in weathering the parent material. They also provide a medium whereby nutrients that have been leached into the lower part of the soil are brought back to the surface. Animal life and micro-organisms break down dead plant tissue into humus, thus releasing plant nutrients.

Human activities, particularly those that alter drainage, maintain fertility, and change the type of vegetation, have an increasingly important effect on soil formation.

Relief

Relief, or the lay of the land, influences soil formation mainly through its effect on the movement of water on and in the soil. The effects of relief are modified by the other four factors of soil formation, especially climate and vegetation.

The profile of soils formed in depressions differs from that of soils formed in steep areas. Tonka soils, which are in depressions, exhibit an advanced degree of horizonation because of the alternating wetting and drying cycles that occur in the depressions. Zahl soils, which are steeper than the Tonka soils, exhibit a minimal degree of horizonation. Gently sloping soils generally support a more luxuriant plant cover than steeper soils. The steeper Cabba and Flasher soils in this county generally have a sparse cover of vegetation, have lime close to the surface, and are low in content of organic matter. They have minimally developed profiles.

Time

The formation of a soil is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil profile.

More time has been available for the formation of Williams soils on glacial till plains than for the formation of Korchea soils on flood plains along the White Earth River. The forces of soil formation have been continually acting on the parent material of Williams soils. As a result, these soils have well defined horizons and a high content of organic matter. Korchea soils are occasionally flooded and receive new material during each flood. They do not have distinct horizons and have a low content of organic matter.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Armstrong, C.A. 1971. Ground-water resources of Burke and Mountrail Counties, North Dakota. N. Dak. Geol. Surv. Bull. 55, Part III, 86 pp., illus.

(4) Arnold, R.W. Clean brush approach achieves better concepts. (Unpublished)

(5) Cairns, R.R., and W.E. Bowser. 1978. Solonetzic soils and their management. Can. Dep. Agric. Publ. 1391, 37 pp., illus.

(6) Carver, Robert F., and William G. Hamlin. 1986. North Dakota agricultural statistics—1986. N. Dak. Crop and Livest. Rep. Serv. Agric. Stat. No. 55, 114 pp., illus.

(7) Clayton, Lee. 1972. Geology of Mountrail County, North Dakota. N. Dak. Geol. Surv. Bull. 55, Part IV, 70 pp., illus.

(8) Dibble, Leslie, M. Dibble, R. Meiers, G. Reep, and W. Ray Stewart. 1979. A history of Mountrail County. Mountrail County Hist. Soc., 626 pp., illus.

(9) Jakes, Pamela J., and W. Brad Smith. 1982. A second look at North Dakota's timber land. U.S. Dep. Agric., Forest Serv., North-Cent. Forest Exp. Stn. Resour. Bull. NC-58, 86 pp., illus.

(10) Lapham, Macy H., and others. 1910. Soil survey of western North Dakota. U.S. Dep. Agric., Bur. of Soils, 80 pp., illus.

(11) Omodt, H.W., G.A. Johnsgard, D.D. Patterson, and O.P. Olson. 1968. The major soils of North Dakota. N. Dak. State Univ. Agric. Exp. Stn. Bull. 472, 60 pp., illus.

(12) Patterson, D.D., G.A. Johnsgard, M.D. Sweeney, and H.W. Omodt. 1968. Soil survey report, county general soil maps, North Dakota. N. Dak. State Univ. Agric. Exp. Stn. Bull. 473, 150 pp., illus.

(13) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(14) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(15) United States Department of Commerce. 1951. 1950 census report, North Dakota state and county data. Vol. 1, part 34, 19 pp.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that

the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or

into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine

sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $Ca^+ + Mg^{++}$. The degrees of sodicity and their respective ratios are—

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. An A horizon 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon more than 10 inches (25 centimeters) thick.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across

sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Stanley, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	14.4	-5.7	4.4	43	-36	0	0.49	0.16	0.74	2	5.9
February----	22.5	2.5	12.5	48	-28	0	.46	.11	.72	1	5.3
March-------	33.0	11.8	22.4	64	-22	42	.67	.18	.98	2	7.4
April-------	51.1	27.5	39.3	81	3	144	1.54	.48	2.39	4	5.9
May---------	65.3	38.4	51.9	89	19	377	2.48	.82	3.75	6	.8
June--------	74.0	48.3	61.2	92	34	636	3.92	1.63	5.55	8	.0
July--------	81.5	53.5	67.5	99	39	853	2.44	1.19	3.36	6	.0
August------	80.8	50.3	65.6	100	36	794	2.06	.66	3.16	5	.0
September---	67.7	39.6	53.7	94	20	420	2.05	.56	3.22	5	.5
October-----	55.7	29.8	42.8	83	9	180	.99	.15	1.62	3	1.7
November----	35.8	15.6	25.7	66	-14	30	.54	.12	.83	2	5.7
December----	21.7	2.0	11.9	48	-32	17	.49	.21	.70	2	6.1
Yearly:											
Average---	50.3	26.6	38.2	---	---	---	---	---	---	---	---
Extreme---	---	---	---	101	-37	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,493	18.13	13.17	22.72	46	39.3

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Stanley, North Dakota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 14	May 24	May 31
2 years in 10 later than--	May 9	May 18	May 27
5 years in 10 later than--	Apr. 28	May 8	May 19
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 18	Sept. 5	Aug. 28
2 years in 10 earlier than--	Sept. 23	Sept. 10	Sept. 3
5 years in 10 earlier than--	Oct. 4	Sept. 20	Sept. 15

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Stanley, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	134	113	95
8 years in 10	142	121	103
5 years in 10	158	135	118
2 years in 10	173	149	133
1 year in 10	181	157	141

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Parnell silt loam	22,340	1.8
3	Tonka silt loam	5,830	0.5
4	Vallers loam, saline	2,690	0.2
5	Belfield silt loam, 1 to 3 percent slopes	1,320	0.1
9B	Savage silty clay loam, 1 to 6 percent slopes	3,795	0.3
10	Makoti silty clay loam, 1 to 3 percent slopes	2,345	0.2
12	Bowdle loam, 1 to 3 percent slopes	8,815	0.7
14	Divide loam, 0 to 3 percent slopes	4,530	0.4
15	Straw loam, channeled	6,295	0.5
17	Hamerly-Tonka complex, 0 to 3 percent slopes	18,950	1.5
18B	Shambo loam, 1 to 6 percent slopes	10,735	0.9
18C	Shambo loam, 6 to 9 percent slopes	4,090	0.3
19	Nutley silty clay, 1 to 3 percent slopes	17,035	1.4
19B	Nutley silty clay, 3 to 6 percent slopes	5,305	0.4
23	Williams loam, 1 to 3 percent slopes	55,870	4.5
23B	Williams-Zahl loams, 3 to 6 percent slopes	243,295	19.5
24C	Williams-Zahl loams, 6 to 9 percent slopes	103,675	8.3
24E	Zahl-Williams loams, 9 to 25 percent slopes	200,905	16.1
24F	Zahl-Max loams, 25 to 60 percent slopes	35,270	2.8
25C	Zahl-Williams-Bowbells loams, 3 to 9 percent slopes	120,600	9.7
27	Korchea and Straw loams, 0 to 3 percent slopes	3,070	0.3
32	Bowbells loam, 1 to 3 percent slopes	7,655	0.6
35	Bowbells-Tonka complex, 0 to 3 percent slopes	5,860	0.5
39	Farnuf loam, 1 to 3 percent slopes	11,480	0.9
39B	Farnuf-Sakakawea loams, 3 to 6 percent slopes	4,040	0.3
41	Hamerly and Divide loams, saline	8,485	0.7
44B	Lihen loamy sand, loamy substratum, 1 to 6 percent slopes	1,635	0.1
45B	Parshall sandy loam, 1 to 6 percent slopes	2,695	0.2
47B	Lehr loam, 1 to 6 percent slopes	24,290	1.9
49B	Manning sandy loam, 1 to 6 percent slopes	15,585	1.3
50C	Sakakawea loam, 3 to 9 percent slopes	4,695	0.4
51B	Livona sandy loam, 1 to 6 percent slopes	5,085	0.4
53C	Lihen-Sakakawea complex, 3 to 9 percent slopes	1,805	0.1
54E	Wabek loam, 1 to 35 percent slopes	41,995	3.4
55E	Cherry-Cabba complex, 9 to 60 percent slopes	3,055	0.3
57F	Badland-Cabba complex, 9 to 70 percent slopes	9,105	0.7
58B	Noonan-Williams loams, 1 to 6 percent slopes	5,325	0.4
59E	Miranda-Zahl loams, 1 to 25 percent slopes	2,530	0.2
60	Harriet loam	10,720	0.9
62E	Rhoades-Cabba loams, 3 to 25 percent slopes	8,035	0.7
63F	Cabba-Shambo-Arikara complex, 6 to 75 percent slopes	35,655	2.9
65	Southam silty clay loam	13,485	1.1
66E	Flasher-Vebar complex, 9 to 60 percent slopes	2,085	0.2
67B	Rhoades-Savage complex, 1 to 6 percent slopes	5,135	0.4
71B	Miranda-Noonan loams, 1 to 6 percent slopes	1,340	0.1
76	Pits, gravel	825	0.1
80E	Vebar-Flasher-Zahl complex, 6 to 25 percent slopes	3,810	0.3
81F	Cabba-Badland complex, 9 to 70 percent slopes	5,025	0.4
82E	Zahl-Williams-Parnell complex, 0 to 25 percent slopes	50,510	4.1
	Water	73,995	6.0
	Total	1,242,700	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Sunflowers	Crested wheatgrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
2----------------------- Parnell	9	19	15	450	---
3----------------------- Tonka	16	34	26	800	2.7
4----------------------- Vallers	6	13	10	300	1.8
5----------------------- Belfield	28	60	46	1,400	1.4
9B---------------------- Savage	27	57	44	---	1.8
10---------------------- Makoti	31	66	50	1,550	2.3
12---------------------- Bowdle	20	43	33	1,000	2.3
14---------------------- Divide	19	40	31	950	2.3
15---------------------- Straw	---	---	---	---	2.6
17---------------------- Hamerly-Tonka	22	47	36	1,100	2.5
18B--------------------- Shambo	28	60	46	1,400	2.3
18C--------------------- Shambo	20	43	33	1,000	2.3
19---------------------- Nutley	29	62	47	1,450	1.8
19B--------------------- Nutley	25	53	41	1,250	1.8
23---------------------- Williams	28	60	46	1,400	2.3
23B--------------------- Williams-Zahl	24	51	39	1,200	1.8
24C--------------------- Williams-Zahl	17	36	28	850	1.8
24E--------------------- Zahl-Williams	---	---	---	---	1.6
24F--------------------- Zahl-Max	---	---	---	---	1.6
25C--------------------- Zahl-Williams-Bowbells	16	34	26	---	1.6

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Sunflowers	Crested wheatgrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
27----------------------- Korchea and Straw	30	64	49	1,500	2.6
32----------------------- Bowbells	32	---	52	1,600	2.6
35----------------------- Bowbells-Tonka	24	51	39	1,200	2.6
39----------------------- Farnuf	29	62	47	1,450	2.3
39B---------------------- Farnuf-Sakakawea	24	51	39	1,200	1.7
41----------------------- Hamerly and Divide	12	26	20	600	1.8
44B---------------------- Lihen	16	34	26	800	1.6
45B---------------------- Parshall	22	47	36	1,100	1.6
47B---------------------- Lehr	15	32	24	750	1.6
49B---------------------- Manning	14	30	23	700	1.6
50C---------------------- Sakakawea	15	32	24	750	1.1
51B---------------------- Livona	23	49	37	1,150	1.6
53C---------------------- Lihen-Sakakawea	14	30	23	700	1.4
54E---------------------- Wabek	---	---	---	---	0.9
55E---------------------- Cherry-Cabba	9	19	15	450	1.7
57F. Badland-Cabba					
58B---------------------- Noonan-Williams	20	43	33	1,000	1.7
59E---------------------- Miranda-Zahl	---	---	---	---	0.9
60----------------------- Harriet	---	---	---	---	1.4
62E---------------------- Rhoades-Cabba	---	---	---	---	0.9
63F---------------------- Cabba-Shambo-Arikara	---	---	---	---	1.1

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Sunflowers	Crested wheatgrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
65. Southam					
66E. Flasher-Vebar					
67B----------------------- Rhoades-Savage	15	32	24	750	1.3
71B----------------------- Miranda-Noonan	---	---	---	---	1.0
76*. Pits					
80E----------------------- Vebar-Flasher-Zahl	---	---	---	---	1.1
81F*. Cabba-Badland					
82E----------------------- Zahl-Williams-Parnell	---	---	---	---	1.1

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
2 Parnell	Wetland	6,000	5,500	5,000
3 Tonka	Wet Meadow	4,800	4,300	3,500
4 Vallers	Saline Lowland	3,800	3,300	2,800
5 Belfield	Clayey	2,000	1,700	1,400
9B Savage	Clayey	2,100	1,800	1,500
10 Makoti	Silty	2,600	2,200	1,800
12 Bowdle	Silty	2,300	1,900	1,500
14 Divide	Limy Subirrigated	4,000	3,600	3,000
15 Straw	Overflow	3,000	2,600	2,200
17*:				
Hamerly	Limy Subirrigated	4,000	3,600	3,000
Tonka	Wet Meadow	4,800	4,300	3,500
18B, 18C Shambo	Silty	2,300	2,000	1,600
19, 19B Nutley	Clayey	2,300	2,000	1,700
23 Williams	Silty	2,500	2,100	1,700
23B*, 24C*:				
Williams	Silty	2,500	2,100	1,700
Zahl	Thin Upland	2,300	1,900	1,600
24E*:				
Zahl	Thin Upland	2,300	1,900	1,600
Williams	Silty	2,500	2,100	1,700
24F*:				
Zahl	Thin Upland	2,300	1,900	1,600
Max	Silty	2,500	2,100	1,700
25C*:				
Zahl	Thin Upland	2,300	1,900	1,600

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
25C*:				
Williams	Silty	2,500	2,100	1,700
Bowbells	Silty	2,700	2,300	1,900
27*:				
Korchea	Overflow	3,000	2,600	2,200
Straw	Overflow	3,000	2,600	2,200
32 Bowbells	Overflow	3,300	2,900	2,500
35*:				
Bowbells	Overflow	3,300	2,900	2,500
Tonka	Wet Meadow	4,800	4,300	3,500
39 Farnuf	Silty	2,500	2,100	1,700
39B*:				
Farnuf	Silty	2,500	2,100	1,700
Sakakawea	Thin Upland	2,300	1,900	1,600
41*:				
Hamerly	Saline Lowland	3,200	2,800	2,400
Divide	Saline Lowland	3,200	2,800	2,400
44B Lihen	Sands	---	---	---
45B Parshall	Sandy	2,600	2,200	1,800
47B Lehr	Shallow to Gravel	1,900	1,600	1,300
49B Manning	Sandy	2,400	2,000	1,600
50C Sakakawea	Thin Upland	2,300	1,900	1,600
51B Livona	Sandy	2,600	2,200	1,800
53C*:				
Lihen	Sandy	2,600	2,200	1,800
Sakakawea	Thin Upland	2,300	1,900	1,600
54E Wabek	Very Shallow	1,000	800	600
55E*:				
Cherry	Silty	2,300	2,000	1,600
Cabba	Shallow	1,700	1,400	1,100

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
57F*:				
Badland	None Assigned	---	---	---
Cabba	Shallow	1,700	1,400	1,100
58B*:				
Noonan	Claypan	1,900	1,600	1,300
Williams	Silty	2,500	2,100	1,700
59E*:				
Miranda	Thin Claypan	1,100	800	600
Zahl	Thin Upland	2,300	1,900	1,600
60 Harriet	Saline Lowland	3,200	2,800	2,400
62E*:				
Rhoades	Thin Claypan	900	700	400
Cabba	Shallow	1,700	1,400	1,100
63F*:				
Cabba	Shallow	1,700	1,400	1,100
Shambo	Silty	2,300	2,000	1,600
Arikara	None Assigned	---	---	---
65 Southam	None Assigned	---	---	---
66E*:				
Flasher	Shallow	1,700	1,400	1,100
Vebar	Sandy	2,200	1,800	1,500
67B*:				
Rhoades	Thin Claypan	900	700	400
Savage	Clayey	2,100	1,800	1,500
71B*:				
Miranda	Thin Claypan	1,100	800	600
Noonan	Claypan	1,900	1,600	1,300
76* Pits	None Assigned	---	---	---
80E*:				
Vebar	Sandy	2,200	1,800	1,500
Flasher	Shallow	1,700	1,400	1,100
Zahl	Thin Upland	2,300	1,900	1,600
81F*:				
Cabba	Shallow	1,700	1,400	1,100

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
81F*:				
Badland	None Assigned	---	---	---
82E*:				
Zahl	Thin Upland	2,300	1,900	1,600
Williams	Silty	2,500	2,100	1,700
Parnell	Wetland	6,000	5,500	5,000

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2----------------- Parnell	Siberian peashrub, American plum, redosier dogwood.	Black Hills spruce, common chokecherry, Siberian crabapple, lilac, eastern redcedar.	Green ash---------	Golden willow-----	Plains cottonwood.
3----------------- Tonka	Redosier dogwood, American plum, Siberian peashrub.	Siberian crabapple, Black Hills spruce, lilac, eastern redcedar, common chokecherry.	Green ash---------	Golden willow-----	Plains cottonwood.
4----------------- Vallers	Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, Russian olive.	---	---	---
5----------------- Belfield	Siberian peashrub, golden currant, American plum, lilac.	Green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper, Russian olive, common chokecherry.	Siberian elm------	---	---
9B---------------- Savage	---	Lilac, American elm, Russian olive, Siberian peashrub, common chokecherry, eastern redcedar, Amur honeysuckle, Black Hills spruce.	Bur oak, green ash, ponderosa pine, Siberian crabapple.	---	---
10---------------- Makoti	---	Siberian crabapple, common chokecherry, eastern redcedar, Siberian peashrub, American plum.	Bur oak, Black Hills spruce, green ash, ponderosa pine, golden willow.	---	Plains cottonwood.
12---------------- Bowdle	---	Ponderosa pine, Russian olive, Siberian peashrub, green ash, eastern redcedar, Rocky Mountain juniper.	Siberian elm------	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
14 Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
15. Straw					
17*: Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	Redosier dogwood, American plum, Siberian peashrub.	Siberian crabapple, Black Hills spruce, lilac, eastern redcedar, common chokecherry.	Green ash	Golden willow	Plains cottonwood.
18B, 18C Shambo	---	Black Hills spruce, eastern redcedar, Russian olive, Siberian peashrub, common chokecherry, lilac, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine.	---	---
19, 19B Nutley	American plum, Siberian peashrub, golden currant, lilac.	Russian olive, common chokecherry, green ash, eastern redcedar, ponderosa pine, Rocky Mountain juniper.	Siberian elm	---	---
23 Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
23B*, 24C*:					
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Zahl	Eastern redcedar, Siberian peashrub.	Ponderosa pine, green ash, Russian olive, Rocky Mountain juniper.	Siberian elm	---	---
24E*:					
Zahl.					
Williams.					
24F*:					
Zahl.					
Max.					
25C*:					
Zahl	Eastern redcedar, Siberian peashrub.	Ponderosa pine, green ash, Russian olive, Rocky Mountain juniper.	Siberian elm	---	---
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Siberian crabapple, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Plains cottonwood.
27*:					
Korchea	Peking cotoneaster, American plum.	Black Hills spruce, Siberian crabapple, green ash, common chokecherry, eastern redcedar, Siberian peashrub.	Golden willow, ponderosa pine.	Plains cottonwood	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
27*:					
Straw	---	Eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Amur honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm	Eastern cottonwood.
32 Bowbells	---	Siberian crabapple, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Plains cottonwood.
35*:					
Bowbells	---	Siberian crabapple, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Plains cottonwood.
Tonka	Redosier dogwood, American plum, Siberian peashrub.	Siberian crabapple, Black Hills spruce, lilac, eastern redcedar, common chokecherry.	Green ash	Golden willow	Plains cottonwood.
39 Farnuf	---	Eastern redcedar, lilac, Amur honeysuckle, Siberian peashrub, Russian olive, common chokecherry, American plum.	Green ash, bur oak, ponderosa pine, Siberian crabapple, Black Hills spruce.	---	---
39B*:					
Farnuf	---	Eastern redcedar, lilac, Amur honeysuckle, Siberian peashrub, Russian olive, common chokecherry, American plum.	Green ash, bur oak, ponderosa pine, Siberian crabapple, Black Hills spruce.	---	---
Sakakawea	Siberian peashrub, eastern redcedar.	Green ash, Russian olive, ponderosa pine, Rocky Mountain juniper.	Siberian elm	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
41*:					
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, Russian olive, green ash.	---	---
Divide	Silver buffaloberry, Siberian peashrub.	---	Russian olive, green ash, Siberian elm.	---	---
44B Lihen	American plum, silver buffaloberry.	Bur oak, Siberian crabapple, Siberian peashrub, common chokecherry, Amur honeysuckle, eastern redcedar, lilac.	Ponderosa pine, green ash, Russian olive.	---	---
45B Parshall	Peking cotoneaster, American plum.	Black Hills spruce, Siberian crabapple, green ash, common chokecherry, eastern redcedar, Siberian peashrub.	Golden willow, ponderosa pine.	Plains cottonwood	---
47B Lehr	---	Green ash, ponderosa pine, Russian olive, Siberian peashrub, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
49B Manning	---	Green ash, ponderosa pine, Russian olive, Siberian peashrub, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
50C Sakakawea	Siberian peashrub, eastern redcedar.	Green ash, Russian olive, ponderosa pine, Rocky Mountain juniper.	Siberian elm	---	---
51B Livona	Lilac, silver buffaloberry.	Bur oak, Siberian peashrub, Siberian crabapple, common chokecherry, American plum, eastern redcedar.	Ponderosa pine, green ash, Russian olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
53C*:					
Lihen	American plum, silver buffaloberry.	Bur oak, Siberian crabapple, Siberian peashrub, common chokecherry, Amur honeysuckle, eastern redcedar, lilac.	Ponderosa pine, green ash, Russian olive.	---	---
Sakakawea	Siberian peashrub, eastern redcedar.	Green ash, Russian olive, ponderosa pine, Rocky Mountain juniper.	Siberian elm	---	---
54E. Wabek					
55E*:					
Cherry	---	American plum, lilac, Russian olive, Siberian peashrub, common chokecherry, Black Hills spruce, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine.	---	---
Cabba.					
57F*: Badland.					
Cabba.					
58B*:					
Noonan	Green ash, Russian olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
59E*: Miranda.					
Zahl.					
60. Harriet					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
62E*: Rhoades.					
Cabba.					
63F*: Cabba.					
Shambo	---	Black Hills spruce, eastern redcedar, Russian olive, Siberian peashrub, common chokecherry, lilac, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine.	---	---
Arikara.					
65. Southam					
66E*: Flasher.					
Vebar	Silver buffaloberry, lilac.	Bur oak, Siberian peashrub, eastern redcedar, common chokecherry, American plum, Siberian crabapple.	Russian olive, green ash, ponderosa pine.	---	---
67B*: Rhoades.					
Savage	---	Lilac, American elm, Russian olive, Siberian peashrub, common chokecherry, eastern redcedar, Amur honeysuckle, Black Hills spruce.	Bur oak, green ash, ponderosa pine, Siberian crabapple.	---	---
71B*: Miranda.					
Noonan	Green ash, Russian olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
76*. Pits					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
80E*:					
Vebar	Silver buffaloberry, lilac.	Bur oak, Siberian peashrub, eastern redcedar, common chokecherry, American plum, Siberian crabapple.	Russian olive, green ash, ponderosa pine.	---	---
Flasher.					
Zahl.					
81F*:					
Cabba.					
Badland.					
82E*:					
Zahl.					
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Parnell	Siberian peashrub, American plum, redosier dogwood.	Black Hills spruce, common chokecherry, Siberian crabapple, lilac, eastern redcedar.	Green ash	Golden willow	Plains cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2-------------------- Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3-------------------- Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
4-------------------- Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
5-------------------- Belfield	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
9B------------------- Savage	Slight---------------	Slight---------------	Moderate: slope.	Severe: erodes easily.
10------------------- Makoti	Slight---------------	Slight---------------	Moderate: slope.	Slight.
12------------------- Bowdle	Slight---------------	Slight---------------	Moderate: slope.	Slight.
14------------------- Divide	Slight---------------	Slight---------------	Slight---------------	Slight.
15------------------- Straw	Severe: flooding.	Moderate: flooding.	Slight---------------	Moderate: flooding.
17*:				
Hamerly--------------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka----------------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
18B------------------ Shambo	Slight---------------	Slight---------------	Moderate: slope.	Slight.
18C------------------ Shambo	Slight---------------	Slight---------------	Severe: slope.	Slight.
19, 19B-------------- Nutley	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
23------------------- Williams	Slight---------------	Slight---------------	Moderate: slope.	Slight.
23B*:				
Williams-------------	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Zahl-----------------	Slight---------------	Slight---------------	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
24C*:				
Williams	Slight	Slight	Severe: slope.	Slight.
Zahl	Slight	Slight	Severe: slope.	Slight.
24E*:				
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
24F*:				
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Max	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
25C*:				
Zahl	Slight	Slight	Severe: slope.	Slight.
Williams	Slight	Slight	Severe: slope.	Slight.
Bowbells	Slight	Slight	Moderate: slope.	Slight.
27*:				
Korchea	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Straw	Severe: flooding.	Slight	Slight	Slight.
32 Bowbells	Slight	Slight	Moderate: slope.	Slight.
35*:				
Bowbells	Slight	Slight	Slight	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
39 Farnuf	Slight	Slight	Moderate: slope.	Slight.
39B*:				
Farnuf	Slight	Slight	Moderate: slope.	Slight.
Sakakawea	Slight	Slight	Moderate: slope.	Slight.
41*:				
Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
41*:				
Divide	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
44B Lihen	Slight	Slight	Moderate: slope.	Slight.
45B Parshall	Slight	Slight	Moderate: slope.	Slight.
47B Lehr	Slight	Slight	Moderate: slope.	Slight.
49B Manning	Slight	Slight	Moderate: slope.	Slight.
50C Sakakawea	Slight	Slight	Severe: slope.	Slight.
51B Livona	Slight	Slight	Moderate: slope.	Slight.
53C*:				
Lihen	Slight	Slight	Severe: slope.	Slight.
Sakakawea	Slight	Slight	Severe: slope.	Slight.
54E Wabek	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
55E*:				
Cherry	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
Cabba	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, erodes easily.
57F*:				
Badland.				
Cabba	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, erodes easily.
58B*:				
Noonan	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Williams	Slight	Slight	Moderate: slope.	Slight.
59E*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
59E*:				
Zahl	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
60 Harriet	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium, percs slowly.	Severe: wetness, percs slowly, excess sodium.	Severe: wetness.
62E*:				
Rhoades	Severe: excess sodium.	Severe: excess sodium.	Severe: slope, excess sodium.	Slight.
Cabba	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: erodes easily.
63F*:				
Cabba	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, erodes easily.
Shambo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Arikara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
65 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
66E*:				
Flasher	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope.
Vebar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
67B*:				
Rhoades	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Savage	Slight	Slight	Moderate: slope.	Severe: erodes easily.
71B*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Noonan	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
76*. Pits				

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
80E*:				
Vebar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Flasher	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Moderate: slope.
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
81F*:				
Cabba	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, erodes easily.
Badland.				
82E*:				
Zahl	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Williams	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
2 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
3 Tonka	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
4 Vallers	Fair	Fair	Very poor	Very poor	Good	Good	Fair	Good	Very poor.
5 Belfield	Fair	Good	Fair	Poor	Poor	Very poor	Fair	Very poor	Fair.
9B Savage	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
10 Makoti	Good	Good	Fair	Fair	Poor	Poor	Good	Poor	Fair.
12 Bowdle	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
14 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
15 Straw	Very poor	Very poor	Good	Good	Good	Good	Poor	Good	Good.
17*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
18B, 18C Shambo	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
19 Nutley	Good	Good	Fair	Poor	Poor	Poor	Good	Poor	Poor.
19B Nutley	Good	Good	Fair	Poor	Very poor	Very poor	Good	Very poor	Poor.
23 Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
23B*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
24C*:									
Williams	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
24E*:									
Zahl	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
24E*:									
Williams	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
24F*:									
Zahl	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Max	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
25C*:									
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Williams	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Bowbells	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
27*:									
Korchea	Good	Good	Fair	Good	Poor	Very poor	Good	Very poor	Fair.
Straw	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
32 Bowbells	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
35*:									
Bowbells	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Tonka	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
39 Farnuf	Good	Good	Good	Very poor	Very poor	Very poor	Good	Very poor	Good.
39B*:									
Farnuf	Good	Good	Good	Very poor	Very poor	Very poor	Good	Very poor	Good.
Sakakawea	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
41*:									
Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
Divide	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
44B Lihen	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
45B Parshall	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
47B Lehr	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
49B Manning	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
50C Sakakawea	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
51B Livona	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
53C*:									
Lihen	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Sakakawea	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
54E Wabek	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
55E*:									
Cherry	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Cabba	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
57F*:									
Badland.									
Cabba	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
58B*:									
Noonan	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor	Very poor	Very poor.
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
59E*:									
Miranda	Very poor	Very poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor	Poor.
Zahl	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
60 Harriet	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Poor.
62E*:									
Rhoades	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cabba	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
63F*:									
Cabba	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Shambo	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Arikara	Very poor	Very poor	Fair	Good	Very poor	Very poor	Poor	Very poor	---
65 Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
66E*:									
Flasher	Very poor	Very poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Vebar	Poor	Fair	Good	Very poor	Very poor	Very poor	Fair	Very poor	Good.
67B*:									
Rhoades	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Savage	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
71B*:									
Miranda-----------	Very poor	Very poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor	Poor.
Noonan------------	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor	Very poor	Very poor.
76*. Pits									
80E*:									
Vebar-------------	Poor	Fair	Good	Very poor	Very poor	Very poor	Fair	Very poor	Good.
Flasher-----------	Very poor	Very poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Zahl--------------	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
81F*:									
Cabba-------------	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Badland.									
82E*:									
Zahl--------------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Williams----------	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Parnell-----------	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2----------------- Parnell	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
3----------------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
4----------------- Vallers	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
5----------------- Belfield	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
9B---------------- Savage	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
10---------------- Makoti	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
12---------------- Bowdle	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
14---------------- Divide	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
15---------------- Straw	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
17*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka------------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
18B--------------- Shambo	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
18C--------------- Shambo	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
19, 19B----------- Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
23---------------- Williams	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
23B*, 24C*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
24E*:					
Zahl-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Williams---------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
24F*:					
Zahl-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Max--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
25C*:					
Zahl-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
27*:					
Korchea----------	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Straw------------	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
32---------------- Bowbells	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
35*:					
Bowbells---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
35*:					
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
39 Farnuf	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
39B*:					
Farnuf	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Sakakawea	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
41*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.
44B Lihen	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
45B Parshall	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
47B Lehr	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
49B Manning	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
50C Sakakawea	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
51B Livona	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
53C*:					
Lihen	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Sakakawea	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
54E Wabek	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
55E*:					
Cherry	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Cabba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
57F*:					
Badland.					
Cabba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
58B*:					
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
59E*:					
Miranda	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
60 Harriet	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, low strength.
62E*:					
Rhoades	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Cabba	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Moderate: shrink-swell, slope.
63F*:					
Cabba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Shambo	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Arikara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
65 Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
66E*:					
Flasher	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Vebar	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
67B*:					
Rhoades	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Savage	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
71B*:					
Miranda	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
76*. Pits					
80E*:					
Vebar	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Flasher	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
81F*:					
Cabba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Badland.					
82E*:					
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Williams	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Parnell	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "poor," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3 Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
4 Vallers	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
5 Belfield	Severe: percs slowly.	Moderate: slope.	Severe: too clayey, excess sodium.	Slight	Poor: too clayey, hard to pack, excess sodium.
9B Savage	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
10 Makoti	Severe: percs slowly.	Moderate: slope.	Severe: wetness.	Slight	Fair: too clayey.
12 Bowdle	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
14 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
15 Straw	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding.	Fair: too clayey.
17*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
18B Shambo	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
18C: Shambo	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
19, 19B: Nutley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
23: Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
23B*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24C*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24E*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Williams	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
24F*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Max	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
25C*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
27*:					
Korchea	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27*:					
Straw	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding.	Fair: too clayey.
32 Bowbells	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
35*:					
Bowbells	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
39 Farnuf	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
39B*:					
Farnuf	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sakakawea	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: thin layer.
41*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
44B Lihen	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: too sandy.
45B Parshall	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
47B Lehr	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
49B Manning	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
50C Sakakawea	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: thin layer.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
51B: Livona	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
53C*:					
Lihen	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Sakakawea	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: thin layer.
54E: Wabek	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
55E*:					
Cherry	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
Cabba	Severe: slope, thin layer, seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope.
57F*:					
Badland.					
Cabba	Severe: slope, thin layer, seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope.
58B*:					
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
59E*:					
Miranda	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
60: Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: hard to pack, wetness, excess sodium.
62E*:					
Rhoades	Severe: percs slowly.	Severe: slope.	Severe: too clayey, excess sodium.	Moderate: slope.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
62E*:					
Cabba	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: area reclaim.
63F*:					
Cabba	Severe: slope, thin layer, seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope.
Shambo	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Arikara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
65 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
66E*:					
Flasher	Severe: thin layer, seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope, thin layer.
Vebar	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: slope, seepage.	Poor: area reclaim, thin layer.
67B*:					
Rhoades	Severe: percs slowly.	Moderate: slope.	Severe: too clayey, excess sodium.	Slight	Poor: too clayey, hard to pack.
Savage	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
71B*:					
Miranda	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
76*. Pits					
80E*:					
Vebar	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: slope, seepage.	Poor: area reclaim, thin layer.
Flasher	Severe: thin layer, seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope, thin layer.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
80E*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
81F*:					
Cabba	Severe: slope, thin layer, seepage.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope.
Badland.					
82E*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Williams	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2 Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
3 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
4 Vallers	Poor: wetness.	Probable	Probable	Poor: excess salt, wetness.
5 Belfield	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
9B Savage	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
10 Makoti	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
12 Bowdle	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
14 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
15 Straw	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
17*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
18B, 18C Shambo	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
19, 19B Nutley	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
23: Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
23B*, 24C*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
24E*:				
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
24F*:				
Zahl	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Max	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
25C*:				
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
27*:				
Korchea	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Straw	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
32: Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
35*:				
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
39: Farnuf	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
39B*:				
Farnuf	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sakakawea	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
41*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim, excess salt.
44B Lihen	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
45B Parshall	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
47B Lehr	Good	Probable	Probable	Poor: small stones, area reclaim.
49B Manning	Good	Probable	Probable	Poor: small stones, area reclaim.
50C Sakakawea	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
51B Livona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, large stones.
53C*:				
Lihen	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Sakakawea	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
54E Wabek	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
55E*:				
Cherry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer, slope.
Cabba	Poor: area reclaim, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
57F*: Badland.				
Cabba	Poor: area reclaim, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
58B*: Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
59E*: Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
60 Harriet	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess salt, thin layer.
62E*: Rhoades	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Cabba	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
63F*: Cabba	Poor: area reclaim, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Shambo	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Arikara	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
65 Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
66E*: Flasher	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, thin layer, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
66E*:				
Vebar	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, small stones.
67B*:				
Rhoades	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Savage	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
71B*:				
Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
76*. Pits				
80E*:				
Vebar	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, small stones.
Flasher	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, thin layer, slope.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
81F*:				
Cabba	Poor: area reclaim, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Badland.				
82E*:				
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
2 Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
3 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
4 Vallers	Severe: seepage.	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
5 Belfield	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Percs slowly	Excess sodium, percs slowly.
9B Savage	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
10 Makoti	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
12 Bowdle	Severe: seepage.	Severe: seepage.	Deep to water	Rooting depth	Too sandy	Rooting depth.
14 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
15 Straw	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
17*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
18B, 18C Shambo	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
19 Nutley	Slight	Moderate: hard to pack.	Deep to water	Droughty, slow intake.	Percs slowly	Droughty, percs slowly.
19B Nutley	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slope, droughty, slow intake.	Percs slowly	Droughty, percs slowly.
23 Williams	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
23B*, 24C*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Zahl	Moderate: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
24E*:						
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Williams	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
24F*:						
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Max	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
25C*:						
Zahl	Moderate: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
27*:						
Korchea	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
Straw	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
32 Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
35*:						
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
39 Farnuf	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
39B*:						
Farnuf	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
Sakakawea	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
41*:						
Hamerly	Slight	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave, excess salt.	Wetness, droughty.	Wetness, too sandy.	Excess salt, droughty.
44B Lihen	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
45B Parshall	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
47B Lehr	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
49B Manning	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
50C Sakakawea	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
51B Livona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily, soil blowing.	Erodes easily.
53C*:						
Lihen	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
Sakakawea	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
54E Wabek	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
55E*:						
Cherry	Severe: slope.	Moderate: piping, hard to pack.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Cabba	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, thin layer.	Slope, area reclaim, erodes easily.	Slope, erodes easily, area reclaim.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
57F*: Badland.						
Cabba------------	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, thin layer.	Slope, area reclaim, erodes easily.	Slope, erodes easily, area reclaim.
58B*: Noonan-----------	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Percs slowly---	Excess sodium, percs slowly.
Williams---------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
59E*: Miranda----------	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Percs slowly---	Excess sodium, percs slowly.
Zahl-------------	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
60--------------- Harriet	Slight---------	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess sodium.
62E*: Rhoades----------	Severe: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope.	Slope, percs slowly.	Slope, excess sodium, percs slowly.
Cabba------------	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, thin layer.	Slope, area reclaim, erodes easily.	Slope, erodes easily, area reclaim.
63F*: Cabba------------	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, thin layer.	Slope, area reclaim, erodes easily.	Slope, erodes easily, area reclaim.
Shambo-----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope----------	Slope.
Arikara----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope----------	Slope.
65--------------- Southam	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
66E*: Flasher----------	Severe: seepage, slope.	Severe: thin layer.	Deep to water	Slope, droughty, fast intake.	Slope, area reclaim, soil blowing.	Slope, droughty, area reclaim.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
66E*:						
Vebar	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, thin layer.	Slope, area reclaim, soil blowing.	Slope, area reclaim.
67B*:						
Rhoades	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope.	Percs slowly	Excess sodium, percs slowly.
Savage	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
71B*:						
Miranda	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Percs slowly	Excess sodium, percs slowly.
Noonan	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Percs slowly	Excess sodium, percs slowly.
76*. Pits						
80E*:						
Vebar	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, thin layer.	Slope, area reclaim, soil blowing.	Slope, area reclaim.
Flasher	Severe: seepage, slope.	Severe: thin layer.	Deep to water	Slope, droughty, fast intake.	Slope, area reclaim, soil blowing.	Slope, droughty, area reclaim.
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
81F*:						
Cabba	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, thin layer.	Slope, area reclaim, erodes easily.	Slope, erodes easily, area reclaim.
Badland.						
82E*:						
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Williams	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
2 Parnell	0-8	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	8-60	Clay, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
3 Tonka	0-14	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	14-42	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	42-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
4 Vallers	0-6	Loam	ML, CL-ML, CL	A-4, A-6	0	95-100	90-100	80-90	65-80	25-40	5-20
	6-28	Clay loam, loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-80	25-40	5-20
	28-57	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-80	25-40	5-20
	57-60	Coarse sandy loam, very gravelly sand.	SM, GM, GP, SP-SM	A-1, A-2-4, A-4, A-3	0-5	40-100	25-100	10-70	2-40	<30	NP-5
5 Belfield	0-9	Silt loam	CL	A-6	0	100	100	85-100	60-90	20-40	10-25
	9-35	Silty clay, silty clay loam, clay loam.	CH, CL	A-7, A-6	0	100	100	90-100	70-100	35-65	15-40
	35-60	Silty clay, silty clay loam, clay loam.	CH, CL	A-7, A-6	0	100	100	90-100	70-100	30-55	10-30
9B Savage	0-5	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-45	15-30
	5-16	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
	16-48	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
	48-60	Silty clay loam, silty clay, clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
10 Makoti	0-6	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-45	10-25
	6-20	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	60-95	20-45	3-28
	20-60	Stratified loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-95	20-45	3-28
12 Bowdle	0-7	Loam	ML, CL	A-6, A-4	0	100	95-100	85-95	55-80	30-40	7-15
	7-26	Loam, gravelly loam.	CL, ML	A-4, A-6	0-5	95-100	75-100	70-95	50-75	30-40	8-15
	26-60	Very gravelly sand, gravelly coarse sand, very gravelly coarse sand.	SM, SW-SM, SP-SM	A-1, A-2	0-5	60-95	50-85	25-50	5-30	<30	NP-5
14 Divide	0-7	Loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	7-23	Loam, sandy clay loam, gravelly loam.	CL, CL-ML, SM-SC, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	23-60	Stratified loamy fine sand to very gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-85	15-65	10-40	5-25	<30	NP-5

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
15--------------- Straw	0-26	Loam-------------	CL-ML	A-4	0	95-100	90-100	85-100	60-90	20-30	5-10
	26-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-100	60-85	25-40	5-20
17*: Hamerly---------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	8-34	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	34-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Tonka-----------	0-14	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	14-42	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	42-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
18B, 18C--------- Shambo	0-5	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-35	3-13
	5-47	Loam, silt loam, clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-40	3-18
	47-60	Stratified loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-40	3-18
19, 19B---------- Nutley	0-5	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	5-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
23--------------- Williams	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
23B*, 24C*: Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	90-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6, A-7	0-1	90-100	90-100	80-95	60-80	25-45	10-25
24E*: Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
24F*: Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
24F*:											
Max-------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	7-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
25C*:											
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells--------	0-7	Loam-------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	20-40	3-23
	7-30	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
	30-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
27*:											
Korchea---------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	90-100	75-95	50-70	15-30	5-15
	6-60	Stratified fine sandy loam to silty clay loam.	SM-SC, CL-ML, CL, SC	A-4, A-6, A-7	0	95-100	90-100	70-100	40-95	20-50	5-20
Straw-----------	0-26	Loam-------------	CL-ML	A-4	0	95-100	90-100	85-100	60-90	20-30	5-10
	26-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-100	60-85	25-40	5-20
32--------------- Bowbells	0-7	Loam-------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	20-40	3-23
	7-30	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
	30-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
35*:											
Bowbells--------	0-7	Loam-------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	20-40	3-23
	7-30	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
	30-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
Tonka-----------	0-14	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	14-42	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	42-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
39--------------- Farnuf	0-5	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	85-95	65-80	25-40	5-20
	5-23	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	80-95	55-85	30-50	15-25
	23-41	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	80-95	70-95	35-50	15-25
	41-60	Loam, clay loam, silty clay loam.	CL, CL-ML, CH	A-6, A-7, A-4	0	100	100	75-100	70-100	25-55	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
39B*:											
Farnuf----------	0-5	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	85-95	65-80	25-40	5-20
	5-23	Loam, clay loam	CL	A-6, A-7	0	100	100	80-95	70-85	35-50	15-25
	23-41	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	80-95	70-95	35-50	15-25
	41-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	75-95	70-95	25-50	5-25
Sakakawea-------	0-6	Loam-------------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-95	55-75	25-40	5-20
	6-41	Silt loam, loam	CL, CL-ML	A-4, A-6	0	100	95-100	85-100	65-85	25-40	5-25
	41-60	Stratified loamy sand to silty clay.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-100	10-85	<40	NP-20
41*:											
Hamerly---------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	8-34	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	34-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
Divide----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	7-23	Loam, sandy clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	23-60	Stratified loamy fine sand to very gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
44B------------- Lihen	0-20	Loamy sand-------	SM	A-2	0	100	100	50-80	15-35	---	NP
	20-58	Loamy fine sand, sand, fine sand.	SM	A-2	0	100	100	50-80	15-35	---	NP
	58-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	25-40	5-15
45B------------- Parshall	0-6	Sandy loam-------	SM, ML	A-4, A-2	0	100	100	60-85	30-55	---	NP
	6-60	Loam, sandy loam, loamy sand.	SM, ML	A-4, A-2	0	100	100	60-100	25-55	---	NP
47B------------- Lehr	0-6	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-80	20-40	3-15
	6-15	Loam, sandy clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	80-100	85-95	60-75	25-40	5-15
	15-22	Gravelly coarse sandy loam, gravelly loamy coarse sand.	SM, SP-SM	A-1	0-5	65-90	50-75	30-50	5-15	---	NP
	22-60	Gravelly loamy sand, gravelly sand, very gravelly loamy coarse sand.	SM, SP, GM, GP	A-1	0-5	40-80	25-60	10-35	2-15	---	NP
49B------------- Manning	0-7	Sandy loam-------	SM	A-2, A-4	0	95-100	95-100	60-85	30-50	---	NP
	7-23	Sandy loam, fine sandy loam, loam.	SM, ML, CL, SC	A-2, A-4, A-6	0-3	85-100	80-100	60-95	10-70	<35	NP-15
	23-60	Sand and gravel	GM, SM, GP-GM, SP-SM	A-1, A-2	0-5	25-95	15-90	10-70	5-35	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
50C-------------- Sakakawea	0-6	Loam-------------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-95	55-75	25-40	5-20
	6-41	Silt loam, loam	CL, CL-ML	A-4, A-6	0	100	95-100	85-100	65-85	25-40	5-20
	41-60	Stratified loamy sand to silty clay.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-100	10-85	<40	NP-20
51B-------------- Livona	0-10	Sandy loam-------	SM, ML	A-2, A-4	0-5	95-100	95-100	50-70	30-55	<20	NP
	10-60	Loam, clay loam, sandy clay loam.	CL, SC	A-6, A-7	0-5	95-100	95-100	80-95	45-75	25-50	10-30
53C*:											
Lihen-----------	0-7	Sandy loam-------	SM, ML	A-4, A-2	0	100	100	60-85	30-55	---	NP
	7-60	Loamy fine sand, loamy sand, sand.	SM	A-2	0	100	100	50-80	15-35	---	NP
Sakakawea-------	0-6	Loam-------------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-95	55-75	25-40	5-20
	6-41	Silt loam, loam	CL, CL-ML	A-4, A-6	0	100	95-100	85-100	65-85	25-40	5-20
	41-60	Stratified loamy sand to silty clay.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-100	10-85	<40	NP-20
54E-------------- Wabek	0-6	Loam-------------	ML	A-4	0-1	90-100	90-100	75-90	50-70	25-40	NP-10
	6-12	Gravelly sandy loam, gravelly loam, gravelly coarse sandy loam.	SM, GM	A-2, A-4	0-1	50-100	50-95	50-65	20-40	---	NP
	12-60	Sand and gravel	GM, GP, SM, SP	A-1	0-1	25-90	10-60	5-35	0-25	---	NP
55E*:											
Cherry----------	0-3	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	35-45	15-25
	3-18	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-45	10-30
	18-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
Cabba-----------	0-3	Loam-------------	ML, CL-ML, CL	A-4	0-5	90-100	85-100	70-90	60-80	20-30	NP-10
	3-19	Loam, silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	85-100	80-95	25-35	5-15
	19-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
57F*: Badland.											
Cabba-----------	0-3	Loam-------------	ML, CL-ML, CL	A-4	0-5	90-100	85-100	70-90	60-80	20-30	NP-10
	3-19	Loam, silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	85-100	80-95	25-35	5-15
	19-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
58B*:											
Noonan----------	0-10	Loam, silt loam	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	10-19	Clay loam--------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-85	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	90-100	85-100	70-95	60-80	25-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
58B*:											
Williams	0-6	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
59E*:											
Miranda	0-2	Loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	2-18	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	18-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
Zahl	0-5	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
60 Harriet	0-1	Loam	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	1-17	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	17-60	Stratified sandy loam to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
62E*:											
Rhoades	0-3	Loam	SM, ML, SC, CL	A-4, A-6	0	100	100	75-90	45-65	20-35	NP-15
	3-25	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	80-95	40-75	20-45
	25-60	Silty clay, clay loam, loam.	CL, CH	A-6, A-7	0	100	100	85-100	75-95	35-70	20-40
Cabba	0-3	Loam	ML, CL-ML, CL	A-4	0-5	90-100	85-100	70-90	60-80	20-30	NP-10
	3-19	Loam, silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	85-100	80-95	25-35	5-15
	19-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
63F*:											
Cabba	0-3	Loam	ML, CL-ML, CL	A-4	0-5	90-100	85-100	70-90	60-80	20-30	NP-10
	3-19	Loam, silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	85-100	80-95	25-35	5-15
	19-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Shambo	0-6	Clay loam	ML, CL	A-4, A-6	0	100	100	90-100	70-80	30-40	5-15
	6-24	Loam, silt loam, clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-40	3-18
	24-60	Stratified loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-40	3-18
Arikara	0-4	Loam	CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	70-85	25-45	5-25
	4-60	Loam, clay loam, fine sandy loam.	CL, CL-ML, SC, SM-SC	A-4, A-6, A-7	0	85-100	80-100	70-100	40-85	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
65--------------- Southam	0-9	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	85-100	30-50	10-25
	9-24	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	24-60	Silty clay, silty clay loam, clay.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
66E*:											
Flasher---------	0-4	Loamy sand-------	SM	A-2	0-5	85-100	85-100	50-100	15-35	---	NP
	4-15	Loamy sand, loamy fine sand, fine sand.	SM	A-2	0-5	85-100	85-100	50-100	15-35	---	NP
	15-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Vebar-----------	0-6	Sandy loam-------	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	6-24	Fine sandy loam, loamy fine sand, sandy loam.	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	24-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
67B*:											
Rhoades---------	0-3	Loam-------------	SM, ML, SC, CL	A-4, A-6	0	100	100	75-90	45-65	20-35	NP-15
	3-25	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	80-95	40-75	20-45
	25-60	Silty clay, clay loam, loam.	CL, CH	A-6, A-7	0	100	100	85-100	75-95	35-70	20-40
Savage----------	0-5	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-45	15-30
	5-16	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
	16-48	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
	48-60	Silty clay loam, silty clay, clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-70	20-45
71B*:											
Miranda---------	0-2	Loam-------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	2-18	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	18-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
Noonan----------	0-10	Loam, silt loam	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	10-19	Clay loam--------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
76*. Pits											
80E*:											
Vebar-----------	0-6	Sandy loam-------	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	6-24	Fine sandy loam, loamy fine sand, sandy loam.	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	24-60	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
80E*:											
Flasher---------	0-4	Loamy sand-------	SM	A-2	0-5	85-100	85-100	50-100	15-35	---	NP
	4-15	Loamy sand, loamy fine sand, fine sand.	SM	A-2	0-5	85-100	85-100	50-100	15-35	---	NP
	15-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
81F*:											
Cabba-----------	0-3	Loam-------------	ML, CL-ML, CL	A-4	0-5	90-100	85-100	70-90	60-80	20-30	NP-10
	3-19	Loam, silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	85-100	80-95	25-35	5-15
	19-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Badland.											
82E*:											
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Parnell---------	0-8	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	8-60	Clay, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
2---------------- Parnell	0-8	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-60	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
3---------------- Tonka	0-14	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	14-42	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	42-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate--	0.43		
4---------------- Vallers	0-6	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	0.28	5	4L
	6-28	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate--	0.28		
	28-57	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate--	0.28		
	57-60	>6.0	0.02-0.06	7.4-8.4	4-16	Low-------	0.15		
5---------------- Belfield	0-9	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate--	0.32	3	6
	9-35	0.06-0.2	0.14-0.18	6.6-8.4	<2	High------	0.32		
	35-60	0.06-0.2	0.13-0.16	7.9-9.0	4-16	High------	0.32		
9B--------------- Savage	0-5	0.6-2.0	0.18-0.23	6.1-7.8	<2	Moderate--	0.37	5	7
	5-16	0.06-0.6	0.12-0.20	6.6-7.8	<2	High------	0.37		
	16-48	0.06-0.2	0.12-0.20	7.4-8.4	2-4	High------	0.37		
	48-60	0.06-0.2	0.12-0.20	7.4-8.4	4-8	High------	0.37		
10--------------- Makoti	0-6	0.2-0.6	0.18-0.23	6.6-7.3	<2	Moderate--	0.32	5	7
	6-20	0.2-0.6	0.16-0.24	6.1-7.8	<2	Moderate--	0.32		
	20-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate--	0.43		
12--------------- Bowdle	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.28	4	6
	7-26	0.6-2.0	0.18-0.20	6.1-8.4	<2	Low-------	0.28		
	26-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
14--------------- Divide	0-7	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low-------	0.28	4	4L
	7-23	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low-------	0.28		
	23-60	>6.0	0.03-0.07	7.4-8.4	<2	Low-------	0.10		
15--------------- Straw	0-26	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low-------	0.32	5	5
	26-60	0.6-2.0	0.16-0.19	6.6-8.4	<2	Moderate--	0.32		
17*:									
Hamerly---------	0-8	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate--	0.28	5	4L
	8-34	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.28		
	34-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate--	0.37		
Tonka-----------	0-14	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	14-42	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	42-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate--	0.43		
18B, 18C--------- Shambo	0-5	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low-------	0.28	5	6
	5-47	0.6-2.0	0.17-0.19	6.6-8.4	<2	Moderate--	0.28		
	47-60	0.6-2.0	0.17-0.19	7.4-9.0	<2	Moderate--	0.28		
19, 19B---------- Nutley	0-5	0.06-0.2	0.10-0.16	6.6-8.4	<2	High------	0.28	5	4
	5-60	0.06-0.2	0.08-0.15	7.4-8.4	<2	High------	0.28		
23--------------- Williams	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
23B*, 24C*:									
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
24E*:									
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		
24F*:									
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
Max-------------	0-7	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate--	0.28	5	6
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate--	0.37		
25C*:									
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		
Bowbells--------	0-7	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low-------	0.28	5	6
	7-30	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate--	0.28		
	30-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate--	0.37		
27*:									
Korchea---------	0-6	0.6-2.0	0.17-0.21	6.6-8.4	<2	Low-------	0.28	5	5
	6-60	0.6-2.0	0.16-0.18	7.4-9.0	<2	Moderate--	0.28		
Straw-----------	0-26	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low-------	0.32	5	5
	26-60	0.6-2.0	0.16-0.19	6.6-8.4	<2	Moderate--	0.32		
32--------------- Bowbells	0-7	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low-------	0.28	5	6
	7-30	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate--	0.28		
	30-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate--	0.37		
35*:									
Bowbells--------	0-7	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low-------	0.28	5	6
	7-30	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate--	0.28		
	30-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate--	0.37		
Tonka-----------	0-14	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	14-42	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	42-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate--	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
39---------------- Farnuf	0-5	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.28	5	6
	5-23	0.6-2.0	0.15-0.20	6.1-7.8	<2	Moderate--	0.32		
	23-41	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate--	0.32		
	41-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate--	0.32		
39B*:									
Farnuf----------	0-5	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.28	5	6
	5-23	0.6-2.0	0.15-0.20	6.1-7.8	<2	Moderate--	0.32		
	23-41	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate--	0.32		
	41-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Moderate--	0.32		
Sakakawea--------	0-6	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate--	0.28	5	4L
	6-41	0.6-2.0	0.16-0.22	6.6-8.4	<2	Moderate--	0.28		
	41-60	0.6-2.0	0.08-0.20	7.9-8.4	<2	Moderate--	0.28		
41*:									
Hamerly---------	0-8	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate--	0.28	5	4L
	8-34	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate--	0.28		
	34-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate--	0.37		
Divide----------	0-7	0.6-2.0	0.09-0.11	7.4-8.4	8-16	Low--------	0.28	4	4L
	7-23	0.6-2.0	0.08-0.10	7.9-8.4	8-16	Low--------	0.28		
	23-60	>6.0	0.02-0.04	7.9-8.4	8-16	Low--------	0.10		
44B-------------- Lihen	0-20	6.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2
	20-58	6.0-20	0.06-0.10	7.4-8.4	<2	Low--------	0.17		
	58-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate--	0.37		
45B-------------- Parshall	0-6	2.0-6.0	0.16-0.18	5.6-8.4	<2	Low--------	0.20	5	3
	6-60	2.0-6.0	0.12-0.17	5.6-8.4	<2	Low--------	0.20		
47B-------------- Lehr	0-6	2.0-6.0	0.17-0.22	6.6-7.8	<2	Low--------	0.28	3	5
	6-15	2.0-6.0	0.17-0.20	6.6-8.4	<2	Moderate--	0.28		
	15-22	6.0-20	0.09-0.11	7.4-8.4	<2	Low--------	0.10		
	22-60	>20	0.02-0.04	7.4-8.4	<2	Low--------	0.10		
49B-------------- Manning	0-7	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	4	3
	7-23	2.0-6.0	0.12-0.20	6.6-8.4	<2	Low--------	0.20		
	23-60	>20	0.02-0.08	7.4-8.4	<2	Low--------	0.10		
50C-------------- Sakakawea	0-6	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate--	0.28	5	4L
	6-41	0.6-2.0	0.16-0.22	6.6-8.4	<2	Moderate--	0.28		
	41-60	0.6-2.0	0.08-0.20	7.9-8.4	<2	Moderate--	0.28		
51B-------------- Livona	0-10	0.6-2.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
	10-60	0.2-2.0	0.14-0.19	6.6-8.4	<2	Moderate--	0.37		
53C*:									
Lihen-----------	0-7	2.0-6.0	0.13-0.18	6.1-7.8	<2	Low--------	0.24	5	3
	7-60	6.0-20	0.06-0.10	7.4-8.4	<2	Low--------	0.17		
Sakakawea--------	0-6	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate--	0.28	5	4L
	6-41	0.6-2.0	0.16-0.22	6.6-8.4	<2	Moderate--	0.28		
	41-60	0.6-2.0	0.08-0.20	7.9-8.4	<2	Moderate--	0.28		
54E-------------- Wabek	0-6	2.0-6.0	0.20-0.22	6.6-8.4	<2	Low--------	0.28	2	5
	6-12	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.10		
	12-60	>20	0.02-0.04	7.4-8.4	<2	Low--------	0.10		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
55E*:									
Cherry----------	0-3	0.2-0.6	0.18-0.23	6.6-7.8	<2	Moderate--	0.37	5	7
	3-18	0.06-0.6	0.16-0.22	7.9-9.0	<2	Moderate--	0.37		
	18-60	0.2-0.6	0.13-0.22	7.4-9.0	<8	Moderate--	0.37		
Cabba-----------	0-3	0.6-2.0	0.16-0.20	6.6-8.4	<4	Low-------	0.37	2	4L
	3-19	0.6-2.0	0.14-0.18	7.4-9.0	2-8	Moderate--	0.28		
	19-60	---	---	---	---	----------	----		
57F*:									
Badland.									
Cabba-----------	0-3	0.6-2.0	0.16-0.20	6.6-8.4	<4	Low-------	0.37	2	4L
	3-19	0.6-2.0	0.14-0.18	7.4-9.0	2-8	Moderate--	0.28		
	19-60	---	---	---	---	----------	----		
58B*:									
Noonan----------	0-10	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate--	0.32	3	6
	10-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High------	0.32		
	19-60	0.06-0.2	0.10-0.14	7.4-9.0	2-8	Moderate--	0.32		
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		
59E*:									
Miranda---------	0-2	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.32	3	6
	2-18	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate--	0.32		
	18-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate--	0.32		
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
60--------------- Harriet	0-1	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate--	0.37	3	6
	1-17	<0.06	0.10-0.15	>7.3	4-16	High------	0.37		
	17-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate--	0.37		
62E*:									
Rhoades---------	0-3	0.6-6.0	0.13-0.15	5.6-7.3	<2	Low-------	0.32	3	6
	3-25	<0.06	0.10-0.12	>6.5	2-16	High------	0.32		
	25-60	<0.06	0.10-0.12	>7.3	8-16	High------	0.32		
Cabba-----------	0-3	0.6-2.0	0.16-0.20	6.6-8.4	<4	Low-------	0.37	2	4L
	3-19	0.6-2.0	0.14-0.18	7.4-9.0	2-8	Moderate--	0.28		
	19-60	---	---	---	---	----------	----		
63F*:									
Cabba-----------	0-3	0.6-2.0	0.16-0.20	6.6-8.4	<4	Low-------	0.37	2	4L
	3-19	0.6-2.0	0.14-0.18	7.4-9.0	2-8	Moderate--	0.28		
	19-60	---	---	---	---	----------	----		
Shambo----------	0-6	0.6-2.0	0.17-0.19	6.1-7.3	<2	Moderate--	0.28	5	6
	6-24	0.6-2.0	0.17-0.19	6.6-8.4	<2	Moderate--	0.28		
	24-60	0.6-2.0	0.17-0.19	7.4-9.0	<2	Moderate--	0.28		
Arikara---------	0-4	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate--	0.28	5	6
	4-60	0.6-2.0	0.13-0.20	6.6-9.0	<4	Moderate--	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
65---------------- Southam	0-9	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate--	0.37	5	4
	9-24	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	24-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
66E*:									
Flasher----------	0-4	2.0-6.0	0.08-0.12	6.6-8.4	<2	Low-------	0.17	2	2
	4-15	2.0-6.0	0.08-0.12	6.6-8.4	<2	Low-------	0.17		
	15-60	---	---	---	---	----------	----		
Vebar------------	0-6	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low-------	0.20	4	3
	6-24	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low-------	0.20		
	24-60	---	---	---	---	----------	----		
67B*:									
Rhoades----------	0-3	0.6-6.0	0.13-0.15	5.6-7.3	<2	Low-------	0.32	3	6
	3-25	<0.06	0.10-0.12	>6.5	2-16	High------	0.32		
	25-60	<0.06	0.10-0.12	>7.3	8-16	High------	0.32		
Savage-----------	0-5	0.6-2.0	0.18-0.23	6.1-7.8	<2	Moderate--	0.37	5	7
	5-16	0.06-0.6	0.12-0.20	6.6-7.8	<2	High------	0.37		
	16-48	0.06-0.2	0.12-0.20	7.4-8.4	2-4	High------	0.37		
	48-60	0.06-0.2	0.12-0.20	7.4-8.4	4-8	High------	0.37		
71B*:									
Miranda----------	0-2	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.32	3	6
	2-18	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate--	0.32		
	18-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate--	0.32		
Noonan-----------	0-10	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate--	0.32	3	6
	10-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High------	0.32		
	19-60	0.06-0.2	0.10-0.14	7.4-9.0	2-8	Moderate--	0.32		
76*. Pits									
80E*:									
Vebar------------	0-6	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low-------	0.20	4	3
	6-24	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low-------	0.20		
	24-60	---	---	---	---	----------	----		
Flasher----------	0-4	2.0-6.0	0.08-0.12	6.6-8.4	<2	Low-------	0.17	2	2
	4-15	2.0-6.0	0.08-0.12	6.6-8.4	<2	Low-------	0.17		
	15-60	---	---	---	---	----------	----		
Zahl-------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
81F*:									
Cabba------------	0-3	0.6-2.0	0.16-0.20	6.6-8.4	<4	Low-------	0.37	2	4L
	3-19	0.6-2.0	0.14-0.18	7.4-9.0	2-8	Moderate--	0.28		
	19-60	---	---	---	---	----------	----		
Badland.									
82E*:									
Zahl-------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate--	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate--	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
82E*:									
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate--	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate--	0.37		
Parnell---------	0-8	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-60	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "brief" and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
2-----------------Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
3-----------------Tonka	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
4-----------------Vallers	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
5-----------------Belfield	C	None---------	---	---	>6.0	---	---	>60	---	Low------	High-----	Moderate.
9B----------------Savage	C	None---------	---	---	>6.0	---	---	>60	---	Low------	High-----	Low.
10----------------Makoti	B	None---------	---	---	5.0-6.0	Apparent	Sep-Jun	>60	---	Moderate	High-----	Low.
12----------------Bowdle	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Low.
14----------------Divide	B	None---------	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
15----------------Straw	B	Frequent----	Brief-----	Mar-May	>6.0	---	---	>60	---	Moderate	High-----	Low.
17*:												
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
Tonka------------	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
18B, 18C----------Shambo	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
19, 19B-----------Nutley	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
23----------------Williams	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
23B*, 24C*:												
Williams---------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
23B*, 24C*:												
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
24E*:												
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Williams---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
24F*:												
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Max--------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
25C*:												
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Williams---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Bowbells---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
27*:												
Korchea----------	B	Occasional	Very brief to brief.	Mar-Jun	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Straw------------	B	Occasional	Brief-----	Mar-May	>6.0	---	---	>60	---	Moderate	High-----	Low.
32---------------- Bowbells	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
35*:												
Bowbells---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
35*:												
Tonka------------	C/D	None--------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
39---------------- Farnuf	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
39B*:												
Farnuf-----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Sakakawea--------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
41*:												
Hamerly----------	C	None--------	---	---	2.0-4.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Moderate.
Divide-----------	B	None--------	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
44B-----Lihen	A	None-----	---	---	>6.0	---	---	>60	---	Low-----	High-----	Low.
45B-----Parshall	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
47B-----Lehr	B	None-----	---	---	>6.0	---	---	>60	---	Low-----	Moderate	Low.
49B-----Manning	B	None-----	---	---	>6.0	---	---	>60	---	Low-----	Moderate	Low.
50C-----Sakakawea	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
51B-----Livona	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
53C*:												
Lihen-----	A	None-----	---	---	>6.0	---	---	>60	---	Low-----	High-----	Low.
Sakakawea-----	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
54E-----Wabek	A	None-----	---	---	>6.0	---	---	>60	---	Low-----	Moderate	Low.
55E*:												
Cherry-----	C	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Cabba-----	D	None-----	---	---	>6.0	---	---	10-20	Soft	Moderate	High-----	Low.
57F*:												
Badland.												
Cabba-----	D	None-----	---	---	>6.0	---	---	10-20	Soft	Moderate	High-----	Low.
58B*:												
Noonan-----	D	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Williams-----	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
59E*:												
Miranda-----	D	None-----	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Zahl-----	B	None-----	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
60-----Harriet	D	Occasional	Long-----	Apr-Jun	0-1.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
62E*:												
Rhoades----------	D	None--------	---	---	>6.0	---	---	>60	---	Low------	High-----	Moderate.
Cabba------------	D	None--------	---	---	>6.0	---	---	10-20	Soft	Moderate	High-----	Low.
63F*:												
Cabba------------	D	None--------	---	---	>6.0	---	---	10-20	Soft	Moderate	High-----	Low.
Shambo-----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Arikara----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
65---------------- Southam	D	None--------	---	---	+5-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
66E*:												
Flasher----------	D	None--------	---	---	>6.0	---	---	7-20	Soft	Low------	Moderate	Low.
Vebar------------	B	None--------	---	---	>6.0	---	---	20-40	Soft	Low------	Moderate	Low.
67B*:												
Rhoades----------	D	None--------	---	---	>6.0	---	---	>60	---	Low------	High-----	Moderate.
Savage-----------	C	None--------	---	---	>6.0	---	---	>60	---	Low------	High-----	Low.
71B*:												
Miranda----------	D	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Noonan-----------	D	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
76*. Pits												
80E*:												
Vebar------------	B	None--------	---	---	>6.0	---	---	20-40	Soft	Low------	Moderate	Low.
Flasher----------	D	None--------	---	---	>6.0	---	---	7-20	Soft	Low------	Moderate	Low.
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
81F*:												
Cabba------------	D	None--------	---	---	>6.0	---	---	10-20	Soft	Moderate	High-----	Low.
Badland.												

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
82E*:												
Zahl-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Williams---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Parnell----------	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate that data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ cu ft	Pct
Arikara loam:														
(S86ND061-290)														
Bw2---- 13 to 27	A-6(11)	CL	100	100	100	96	70	---	33	---	37	19	115	14
C------ 35 to 60	A-6(3)	SC	90	87	82	76	46	---	20	---	32	15	118	13
Bowdle loam:														
(S86ND061-297)														
2C----- 32 to 60	A-1-b(0)	SP-SM	91	84	71	43	6	---	1	---	---	NP	130	9
Farnuf loam:														
(S86ND061-300)														
Bt1---- 5 to 13	A-6(6)	CL	100	100	100	95	59	---	25	---	31	15	119	13
C1----- 41 to 49	A-7-6(32)	CH	100	100	100	100	96	---	56	---	53	30	109	16
Korchea loam:														
(S86ND061-295)														
C1----- 7 to 15	A-6(8)	CL	100	100	100	100	76	---	20	---	32	12	121	12
C1'---- 29 to 52	A-6(11)	CL	99	99	99	99	82	---	21	---	34	14	118	13
Lehr loam:														
(S86ND061-296)														
2C----- 22 to 60	A-1-b(0)	SP-SM	88	77	60	31	5	---	1	---	---	NP	129	9
Lihen loamy sand:														
(S85ND061-155)														
A2----- 12 to 23	A-2-4(0)	SM	100	100	100	87	30	---	10	---	21	4	128	9
C2----- 28 to 60	A-2-4(0)	SM	100	100	100	76	16	---	8	---	---	NP	122	12
Makoti loam:														
(S86ND061-263)														
Bt1---- 7 to 17	A-6(10)	CL	100	100	100	99	72	---	27	---	33	16	120	13
Bk----- 25 to 37	A-6(5)	CL	100	100	100	99	60	---	21	---	29	13	126	10
Manning sandy loam:														
(S85ND061-158)														
Bw2---- 12 to 17	A-2-4(0)	SM	94	90	80	57	14	---	5	---	---	NP	134	8
C1----- 22 to 43	A-2-4(0)	SM	98	95	90	67	13	---	3	---	---	NP	128	10
Noonan loam:														
(S86ND061-274)														
Bt----- 7 to 17	A-7-6(20)	CL	100	100	100	94	83	---	36	---	45	24	111	15
Cz----- 40 to 60	A-7-6(16)	CL	94	91	88	76	65	---	33	---	46	28	121	12
Nutley silty clay loam:														
(S85ND061-181)														
Bw1--- 5 to 21	A-7-6(29)	CH	100	100	100	100	96	---	52	---	51	26	109	16
Bw2--- 21 to 42	A-7-6(35)	CH	100	100	100	100	97	---	54	---	52	33	115	14

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ cu ft	Pct
Sakakawea clay loam:														
(S86ND061-301)														
Bk2--- 14 to 21	A-6(17)	CL	100	100	100	99	82	---	39	---	40	22	116	14
C3---- 41 to 60	A-4(1)	CL	100	100	100	91	47	---	19	---	23	10	126	10
Southam silt loam:														
(S86ND061-294)														
Ag3---- 9 to 22	A-7-6(36)	CH	100	100	100	99	95	---	51	---	60	33	100	20
Cg2---- 30 to 60	A-7-6(42)	CH	100	100	100	100	97	---	59	---	63	38	105	18
Wabek loam:														
(S86ND061-244)														
C------ 13 to 60	A-1-b(0)	SP	98	90	60	16	4	---	1	---	---	NP	135	8
Williams loam:														
(S85ND061-141)														
Bt----- 5 to 14	A-6(12)	CL	99	99	97	91	70	---	27	---	38	20	117	14
Bk----- 14 to 23	A-6(13)	CL	100	98	95	89	69	---	34	---	39	21	121	12
Zahl loam:														
(S85ND061-138)														
Bk1---- 8 to 15	A-6(11)	CL	93	92	90	84	66	---	30	---	40	19	117	14
C------ 20 to 60	A-7-6(13)	CL	96	94	91	85	65	---	30	---	42	23	118	13

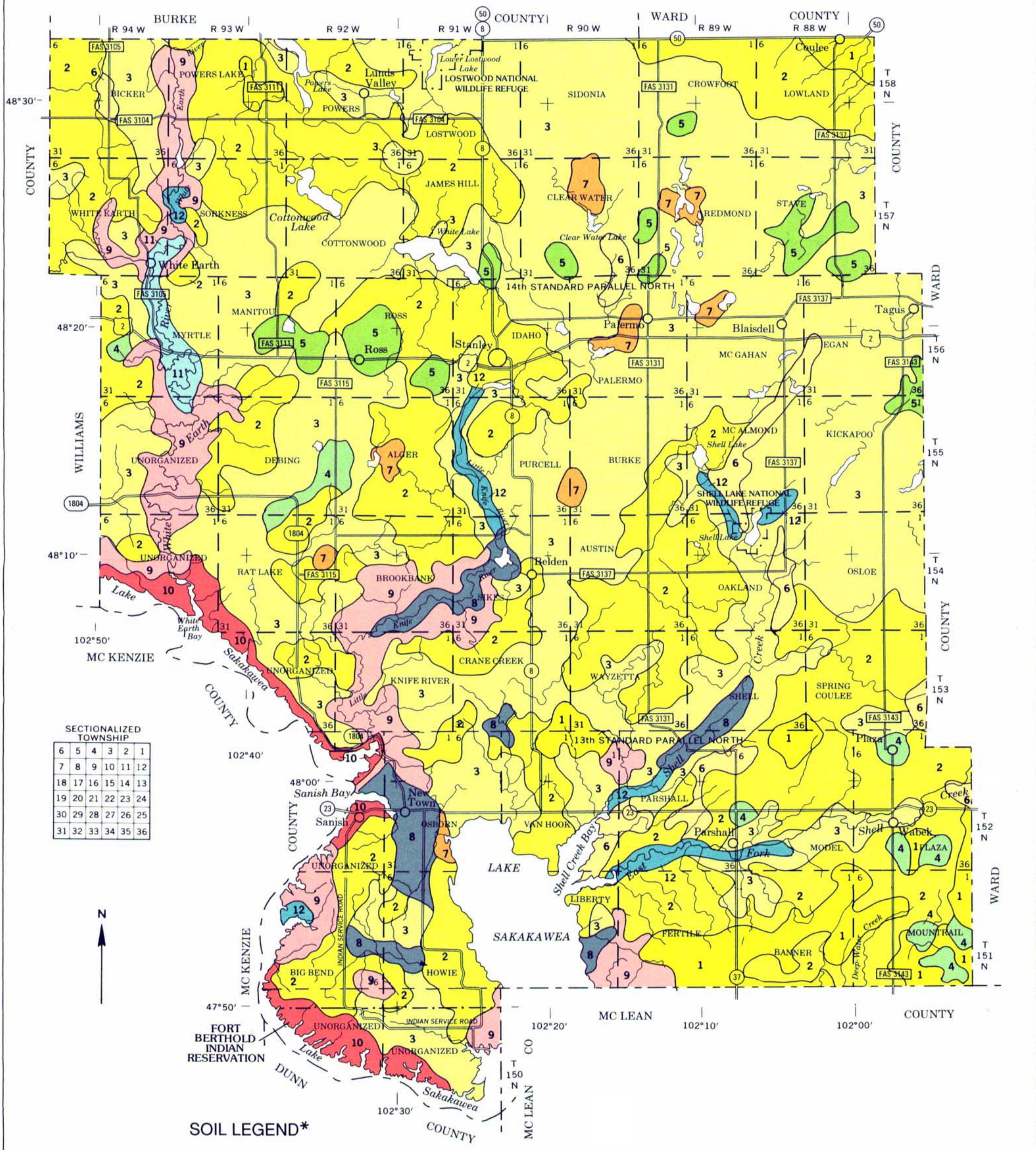
TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arikara	Fine-loamy, mixed, frigid Typic Eutrochrepts
Belfield	Fine, montmorillonitic Glossic Natriborolls
Bowbells	Fine-loamy, mixed Pachic Argiborolls
Bowdle	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Haploborolls
Cabba	Loamy, mixed (calcareous), frigid, shallow Typic Ustorthents
Cherry	Fine-silty, mixed, frigid Typic Ustochrepts
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Farnuf	Fine-loamy, mixed Typic Argiborolls
Flasher	Mixed, frigid, shallow Typic Ustipsamments
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, montmorillonitic, frigid Typic Natraquolls
*Korchea	Fine-loamy, mixed (calcareous), frigid Mollic Ustifluvents
Lehr	Fine-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Lihen	Sandy, mixed Entic Haploborolls
Livona	Fine-loamy, mixed Typic Argiborolls
Makoti	Fine-silty, mixed Pachic Haploborolls
Manning	Coarse-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Max	Fine-loamy, mixed Typic Haploborolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Noonan	Fine-loamy, mixed Typic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Parshall	Coarse-loamy, mixed Pachic Haploborolls
Rhoades	Fine, montmorillonitic Leptic Natriborolls
Sakakawea	Coarse-silty, mixed Typic Calciborolls
Savage	Fine, montmorillonitic Typic Argiborolls
Shambo	Fine-loamy, mixed Typic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Straw	Fine-loamy, mixed Cumulic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Vebar	Coarse-loamy, mixed Typic Haploborolls
Wabek	Sandy-skeletal, mixed Entic Haploborolls
Williams	Fine-loamy, mixed Typic Argiborolls
Zahl	Fine-loamy, mixed Entic Haploborolls

NRCS Accessibility Statement

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SOIL LEGEND*

DEEP, LOAMY SOILS FORMED IN GLACIAL TILL AND ALLUVIUM

- **1** WILLIAMS-HAMERLY-BOWBELLS ASSOCIATION: Deep, medium textured, level and nearly level, well drained to somewhat poorly drained soils
- **2** WILLIAMS-ZAHL ASSOCIATION: Deep, medium textured, undulating and gently rolling, well drained soils
- **3** ZAHL-WILLIAMS ASSOCIATION: Deep, medium textured, gently rolling to hilly, well drained soils

DEEP, LOAMY, SILTY, AND CLAYEY SOILS FORMED IN GLACIOLACUSTRINE DEPOSITS

- **4** FARNUF-MAKOTI ASSOCIATION: Deep, medium textured and moderately fine textured, nearly level and gently sloping, well drained and moderately well drained soils
- **5** NUTLEY ASSOCIATION: Deep, fine textured, nearly level and gently sloping, well drained soils

DEEP, LOAMY AND SANDY SOILS FORMED IN GLACIOFLUVIAL DEPOSITS, EOLIAN DEPOSITS, GLACIOLACUSTRINE DEPOSITS, AND GLACIAL TILL

- **6** MANNING-LIVONA-LIHEN ASSOCIATION: Deep, moderately coarse textured and coarse textured, nearly level to moderately sloping, somewhat excessively drained and well drained soils
- **7** WABEK-LEHR ASSCOIATION: Deep, medium textured, nearly level to steep, excessively drained and somewhat excessively drained soils

DEEP, LOAMY AND SILTY SOILS FORMED IN ALLUVIUM

- **8** SHAMBO-RHOADES-SAVAGE ASSOCIATION: Deep, medium textured and moderately fine textured, nearly level to moderately sloping, well drained and moderately well drained soils

BADLAND AND SHALLOW AND DEEP, LOAMY SOILS FORMED IN MATERIAL WEATHERED FROM BEDROCK, IN GLACIAL TILL, AND IN ALLUVIUM

- **9** CABBA-ZAHL-SHAMBO ASSOCIATION: Shallow and deep, medium textured and moderately fine textured, moderately sloping to very steep, well drained soils
- **10** CABBA-BADLAND ASSOCIATION: Badland and shallow, medium textured, moderately sloping to very steep, well drained soils

DEEP, LOAMY SOILS FORMED IN ALLUVIUM

- **11** STRAW-SHAMBO-KORCHEA ASSOCIATION: Deep, medium textured, level to gently sloping, well drained soils
- **12** HARRIET-KORCHEA ASSOCIATION: Deep, medium textured, level and nearly level, poorly drained and well drained soils

* The texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1989

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS

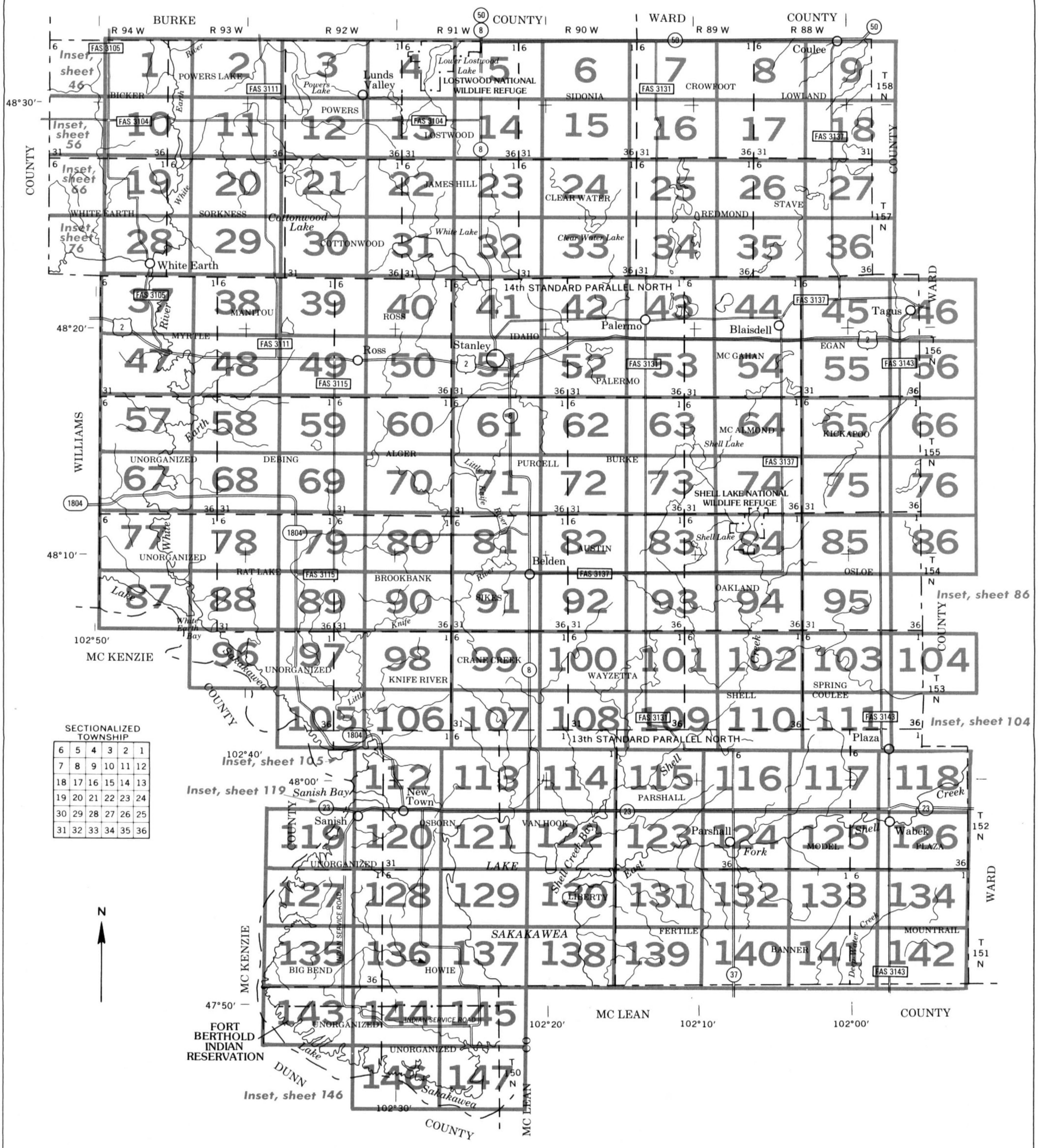
GENERAL SOIL MAP

MOUNTRAIL COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km



Original text from each individual map sheet read:
This soil survey map was compiled by U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1983 – 1984 photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS

MOUNTRAIL COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MOUNTRAIL COUNTY, NORTH DAKOTA

NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
2	Parnell silt loam
3	Tonka silt loam
4	Vallers loam, saline
5	Belfield silt loam, 1 to 3 percent slopes
9B	Savage silty clay loam, 1 to 6 percent slopes
10	Makoti silty clay loam, 1 to 3 percent slopes
12	Bowdle loam, 1 to 3 percent slopes
14	Divide loam, 0 to 3 percent slopes
15	Straw loam, channeled
17	Hamerly-Tonka complex, 0 to 3 percent slopes
18B	Shambo loam, 1 to 6 percent slopes
18C	Shambo loam, 6 to 9 percent slopes
19	Nutley silty clay, 1 to 3 percent slopes
19B	Nutley silty clay, 3 to 6 percent slopes
23	Williams loam, 1 to 3 percent slopes
23B	Williams-Zahl loams, 3 to 6 percent slopes
24C	Williams-Zahl loams, 6 to 9 percent slopes
24E	Zahl-Williams loams, 9 to 25 percent slopes
24F	Zahl-Max loams, 25 to 60 percent slopes
25C	Zahl-Williams-Bowbells loams, 3 to 9 percent slopes
27	Korchea and Straw loams, 0 to 3 percent slopes
32	Bowbells loam, 1 to 3 percent slopes
35	Bowbells-Tonka complex, 0 to 3 percent slopes
39	Farnuf loam, 1 to 3 percent slopes
39B	Farnuf-Sakakawea loams, 3 to 6 percent slopes
41	Hamerly and Divide loams, saline
44B	Lihen loamy sand, loamy substratum, 1 to 6 percent slopes
45B	Parshall sandy loam, 1 to 6 percent slopes
47B	Lehr loam, 1 to 6 percent slopes
49B	Manning sandy loam, 1 to 6 percent slopes
50C	Sakakawea loam, 3 to 9 percent slopes
51B	Livona sandy loam, 1 to 6 percent slopes
53C	Lihen-Sakakawea complex, 3 to 9 percent slopes
54E	Wabek loam, 1 to 35 percent slopes
55E	Cherry-Cabba complex, 9 to 60 percent slopes
57F	Badland-Cabba complex, 9 to 70 percent slopes
58B	Noonan-Williams loams, 1 to 6 percent slopes
59E	Miranda-Zahl loams, 1 to 25 percent slopes
60	Harriet loam
62E	Rhoades-Cabba loams, 3 to 25 percent slopes
63F	Cabba-Shambo-Arikara complex, 6 to 75 percent slopes
65	Southam silty clay loam
66E	Flasher-Vebar complex, 9 to 60 percent slopes
67B	Rhoades-Savage complex, 1 to 6 percent slopes
71B	Miranda-Noonan loams, 1 to 6 percent slopes
76	Pits, gravel
80E	Vebar-Flasher-Zahl complex, 6 to 25 percent slopes
81F	Cabba-Badland complex, 9 to 70 percent slopes
82E	Zahl-Williams-Parnell complex, 0 to 25 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

National, state or province

County or parish

Minor civil division

Reservation (national forest or park, state forest or park, and large airport)

Land grant

Limit of soil survey (label)

Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Swift Airport

Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

Divided (median shown if scale permits)

Other roads

Trail

ROAD EMBLEM & DESIGNATIONS

Interstate — 21

Federal — 173

State — 28

County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

Without road

With road

With railroad

DAMS

Large (to scale)

Medium or Small (shown only if 10 acres or larger) — water, w

PITS

Gravel pit

Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

Farmstead, house (omit in urban areas)

Church (named)

School

Indian mound (label) — Indian Mound

Located object (label) — Tower

Tank (label) — Gas

Wells, oil or gas

Windmill

Kitchen midden

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Double-line (label) — CANAL

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial — water, w

Intermittent — int, i

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Spring

Well, artesian

Well, irrigation

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 10, 24E

ESCARPMENTS

Bedrock (points down slope)

Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

Blowout

Clay spot

Gravelly spot

Gumbo, slick or scabby spot (sodic)

Dumps and other similar non soil areas

Prominent hill or peak

Rock outcrop (includes sandstone and shale)

Saline spot

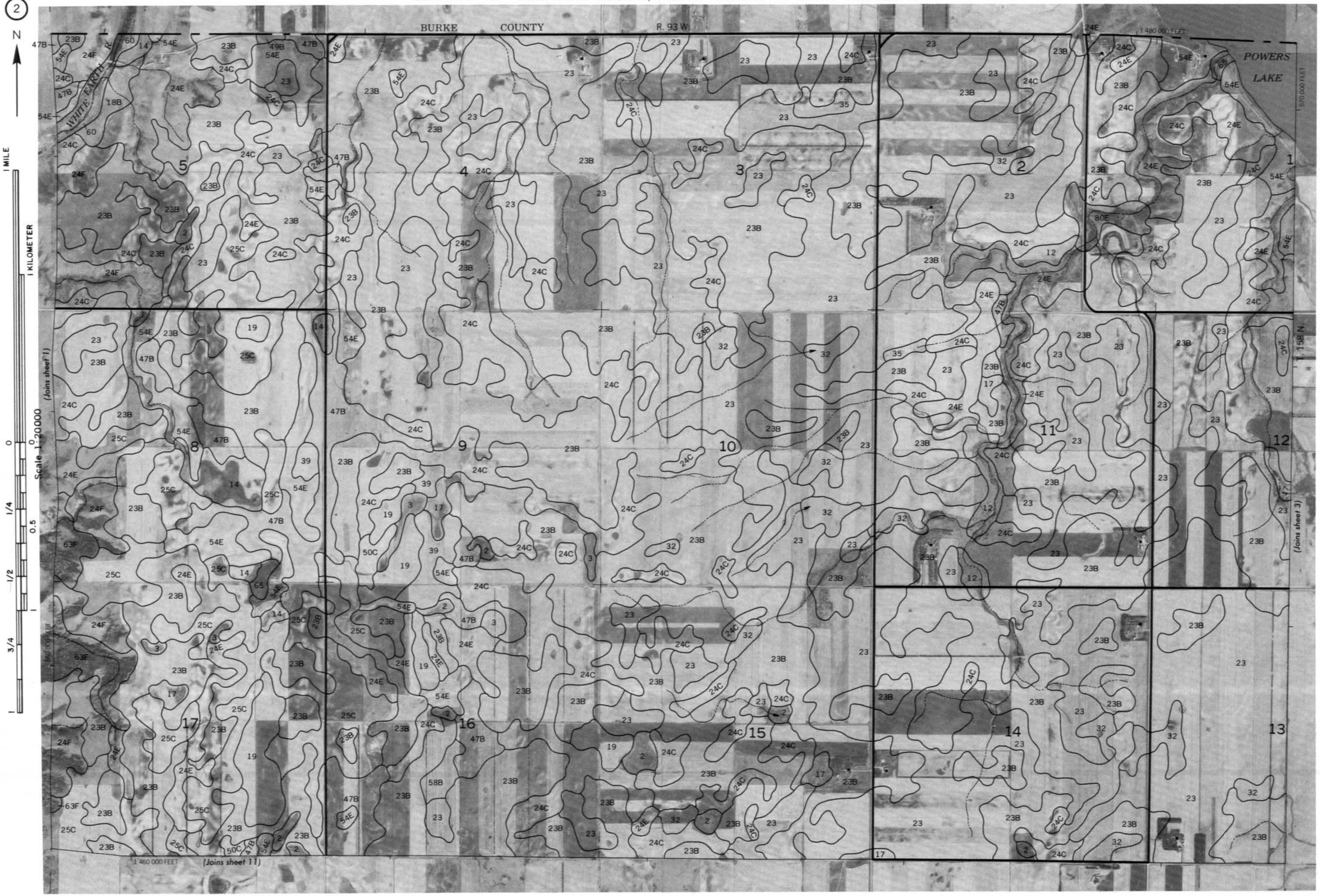
Sandy spot

Severely eroded spot

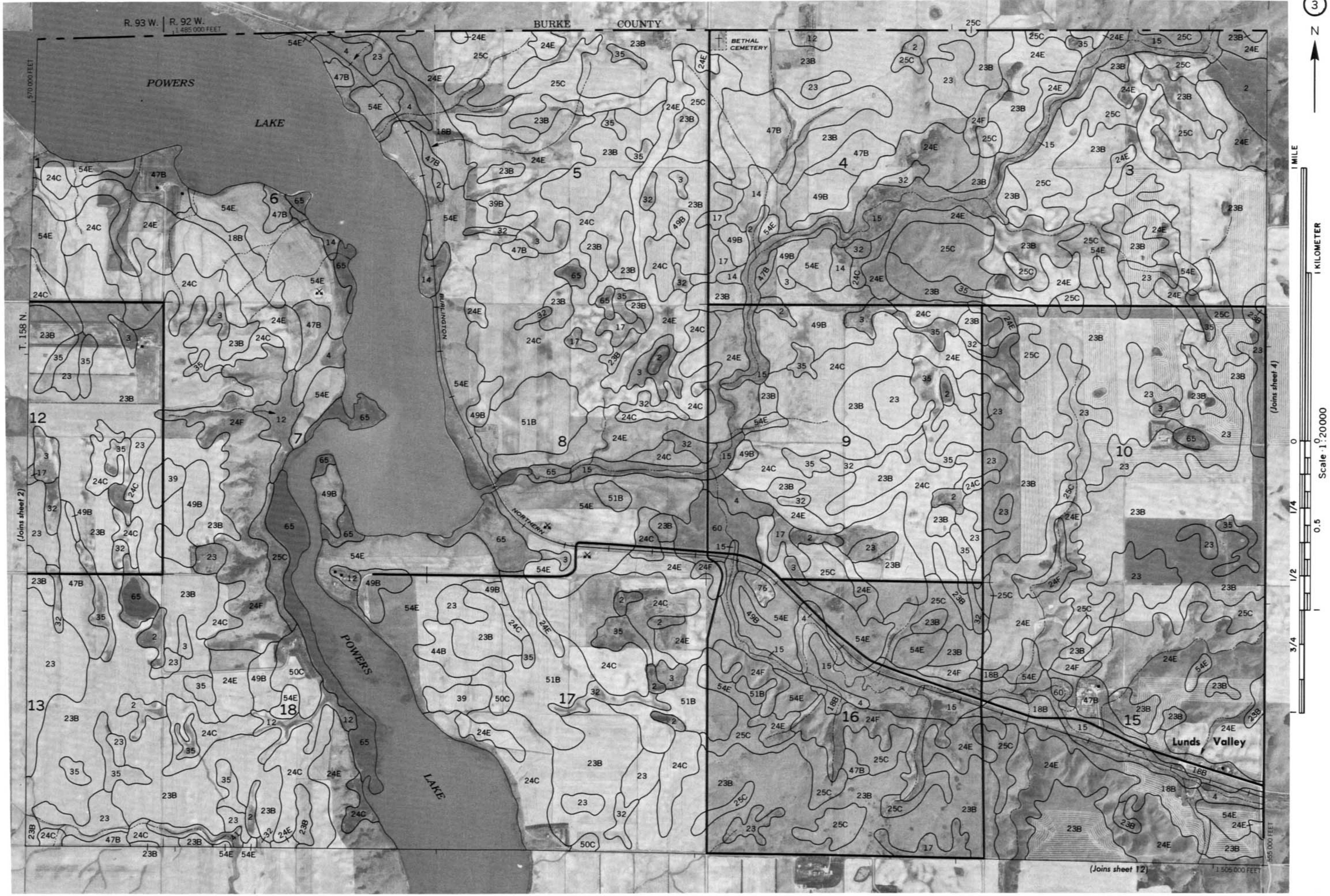
Slide or slip (tips point upslope)

Stony spot, very stony spot

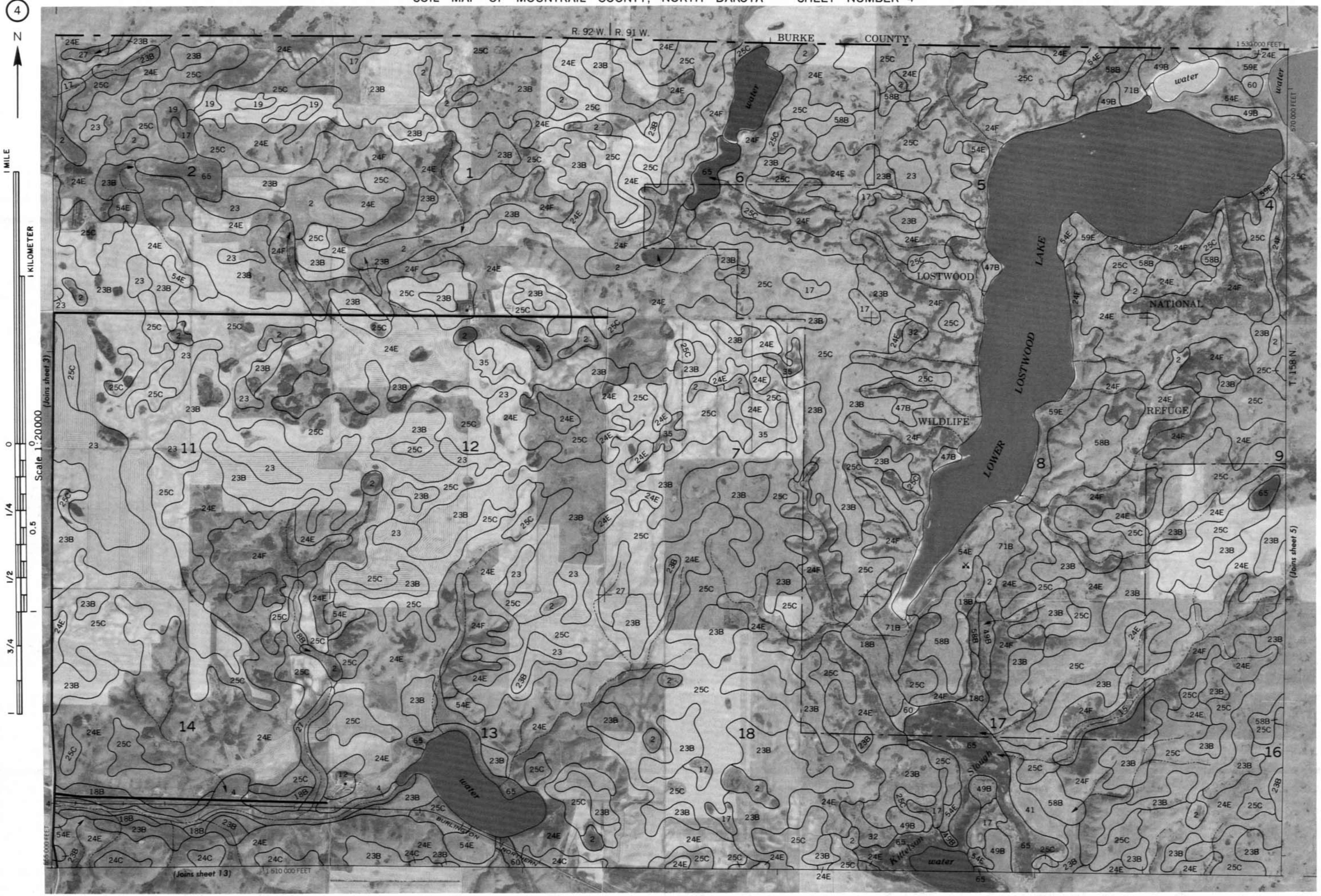
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 1


2
N
BURKE COUNTY
R. 93 W.
POWERS LAKE
WHITE EARTH R.
1 480 000 FEET
570 000 FEET
T. 158 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 11)
1 460 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

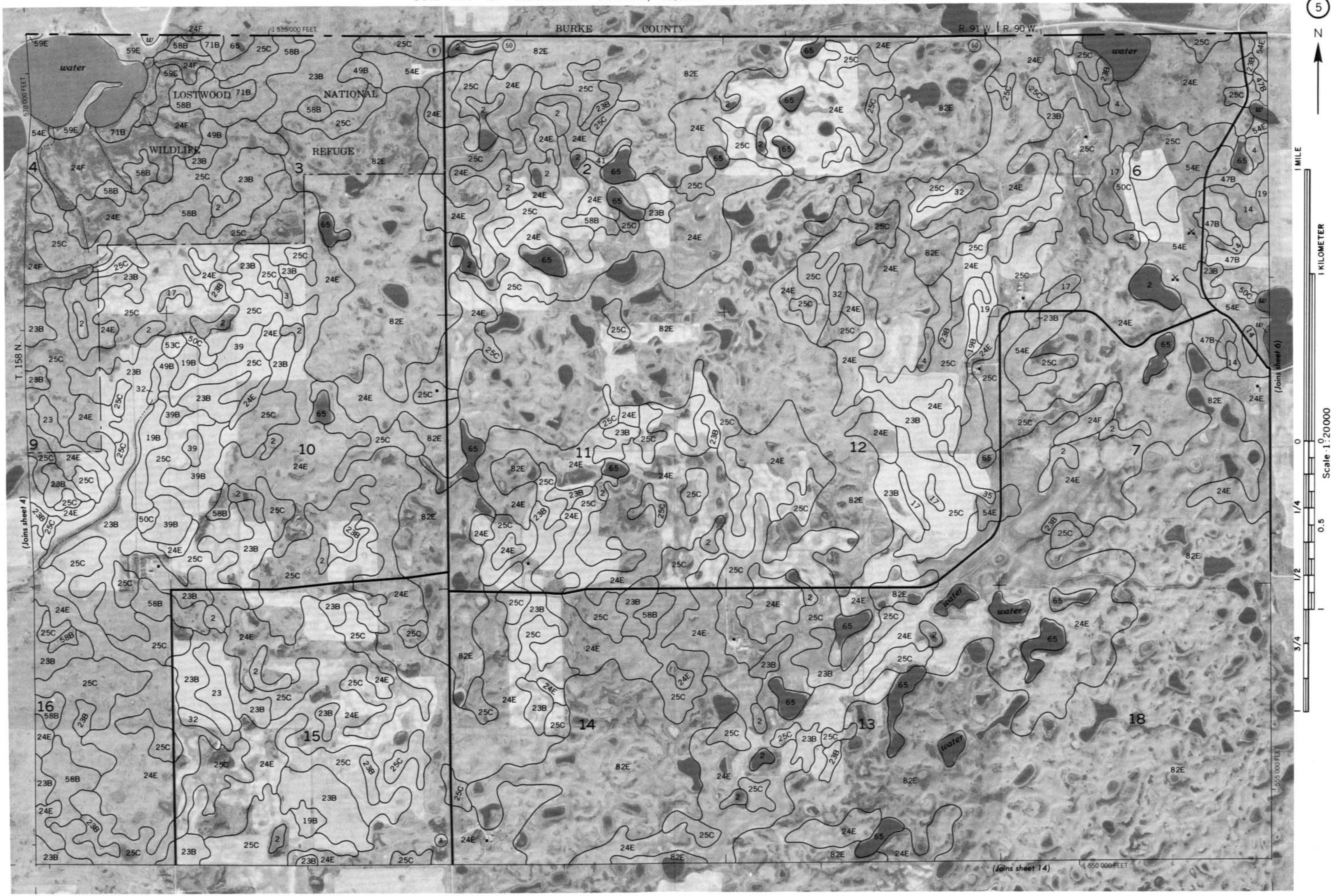
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 3



SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 4



SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 5



6

N

1 MILE

1 KILOMETER

0

1/4

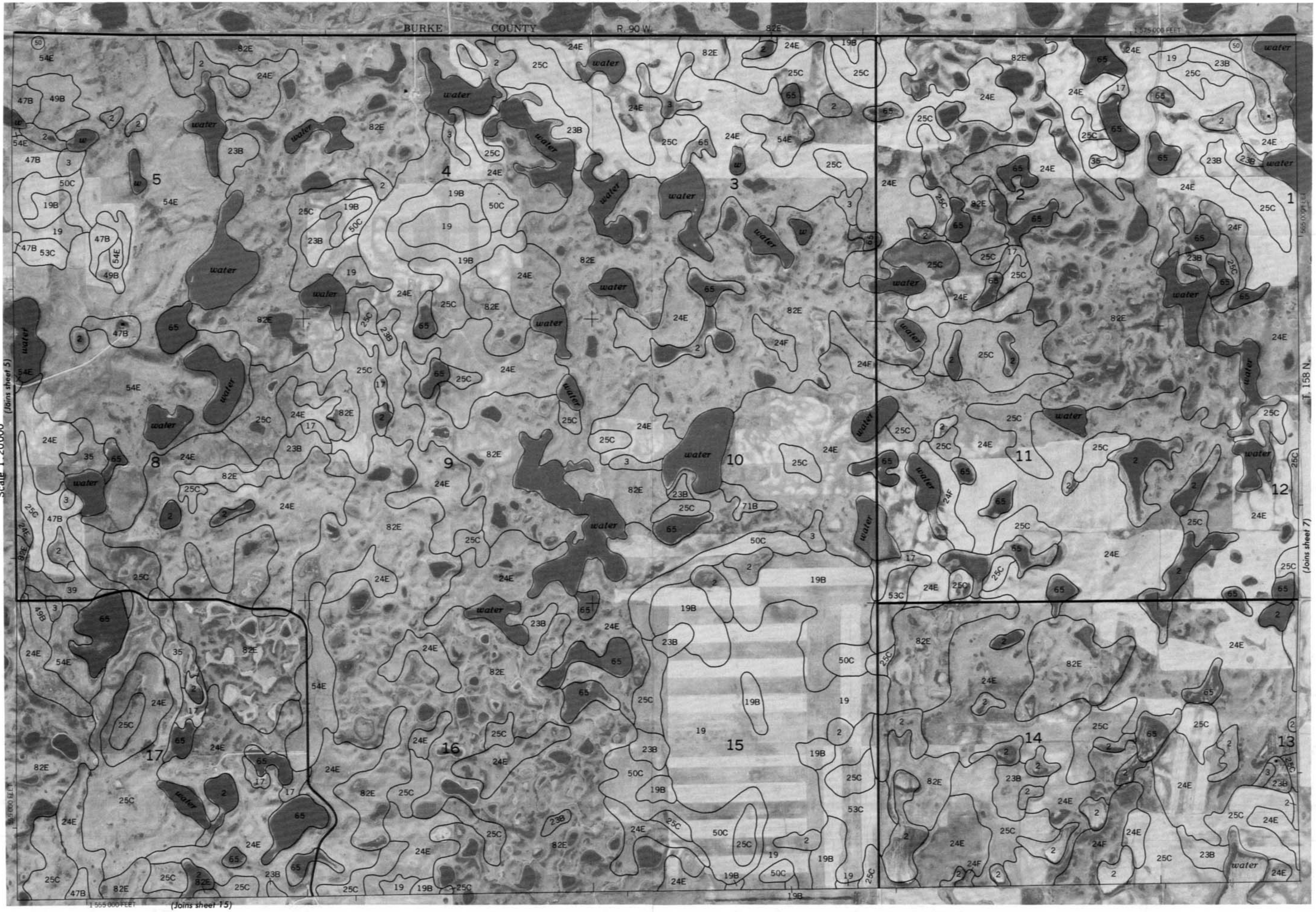
0.5

1/2

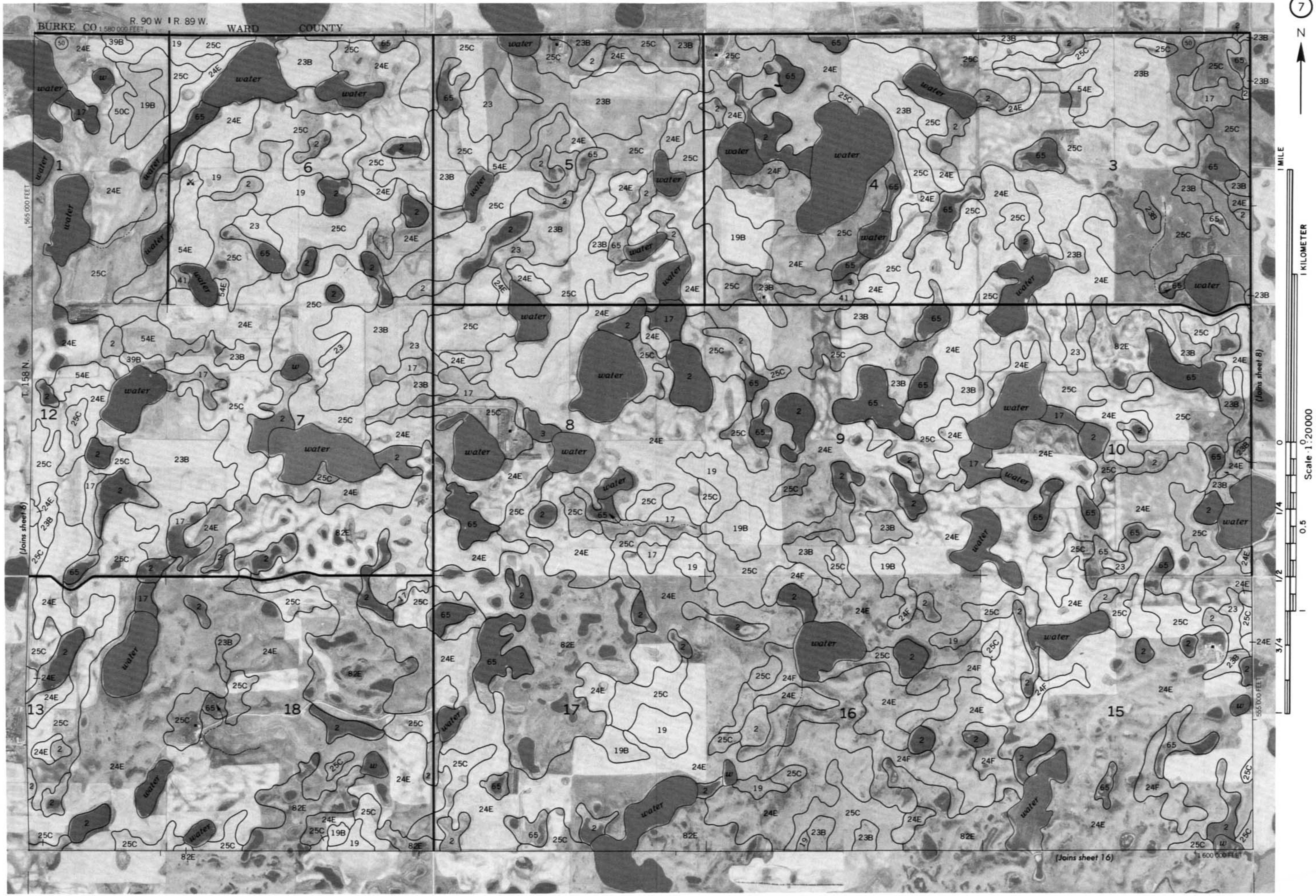
3/4

1

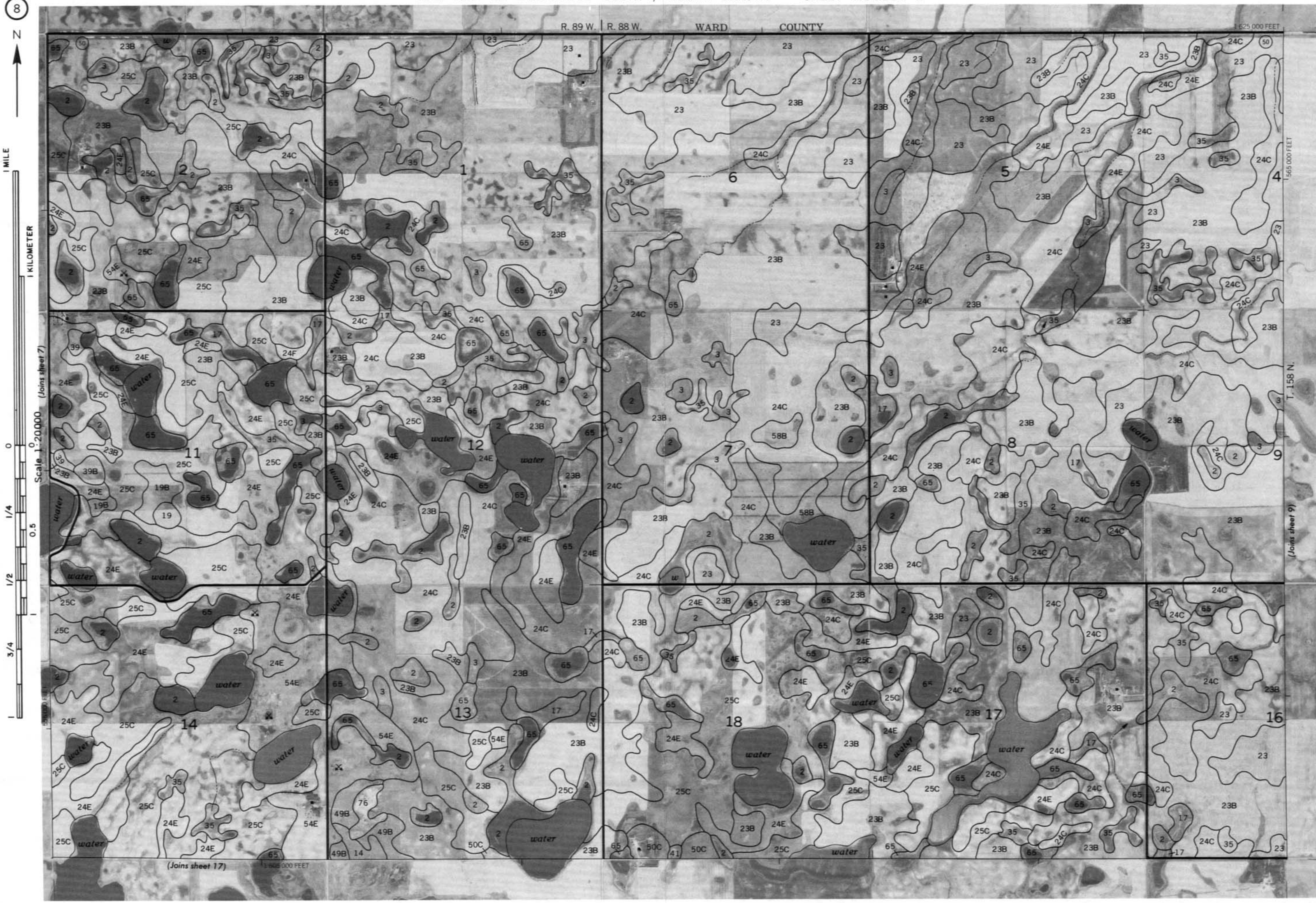
Scale 1:20000



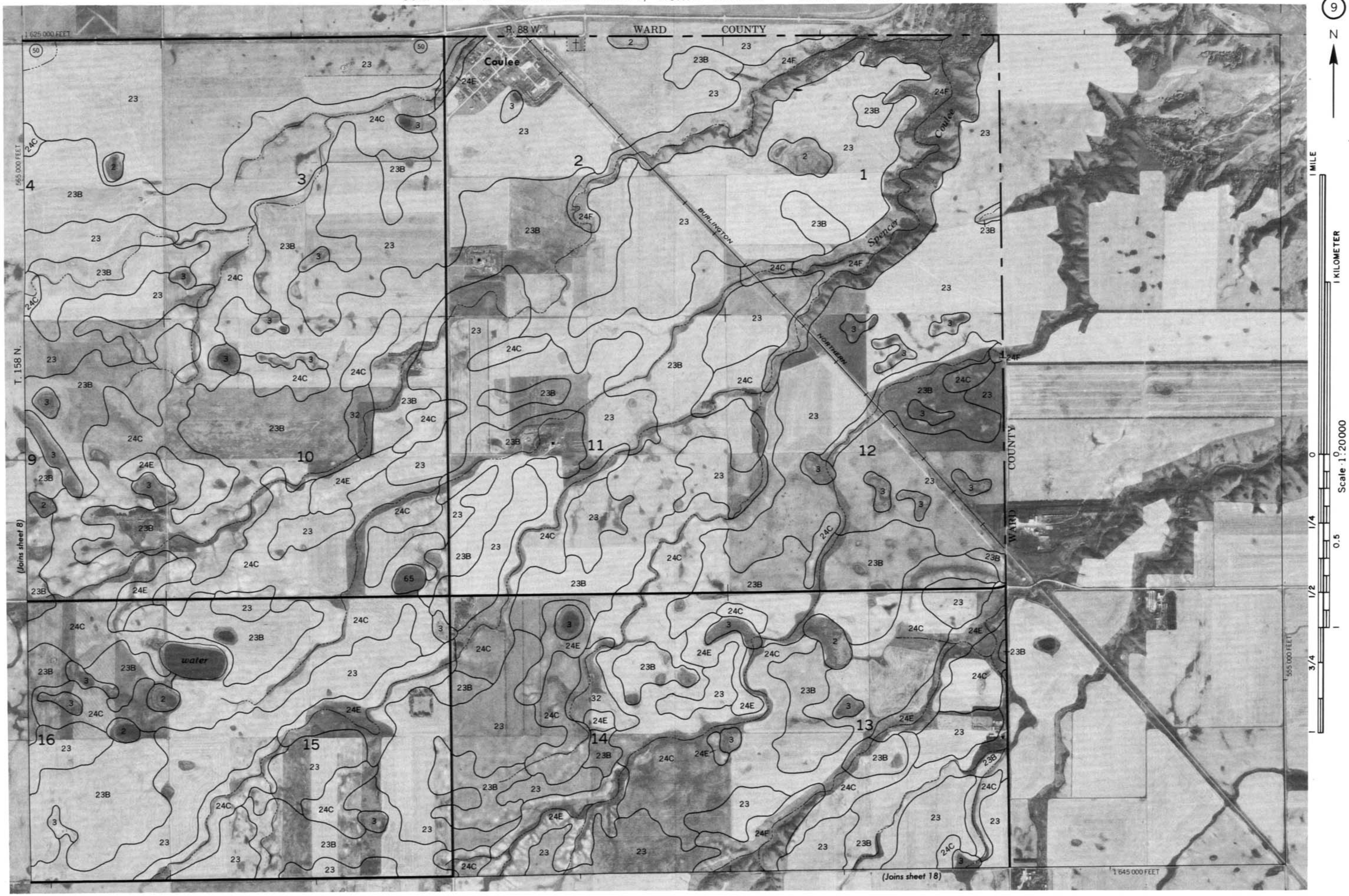
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 7



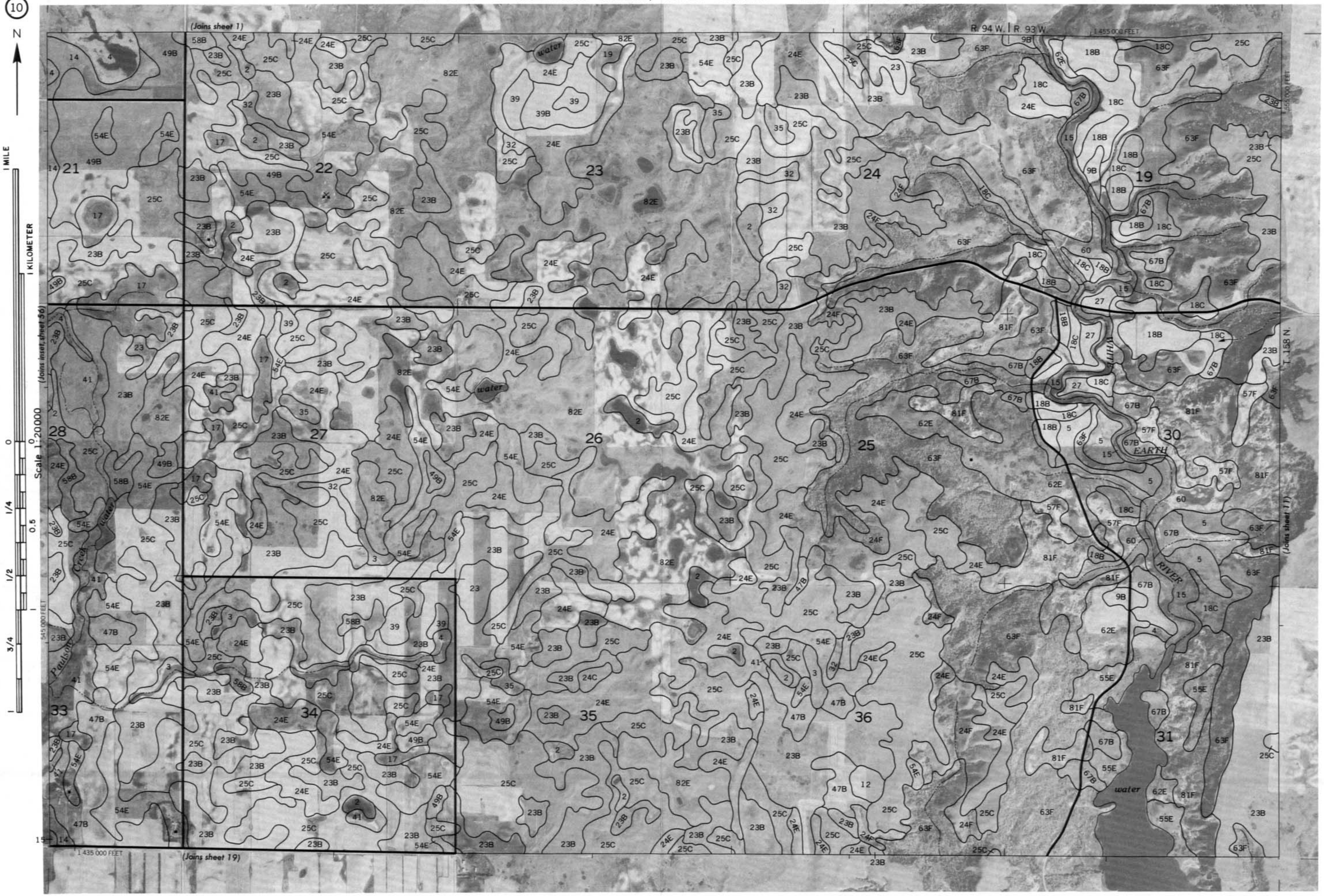
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 8



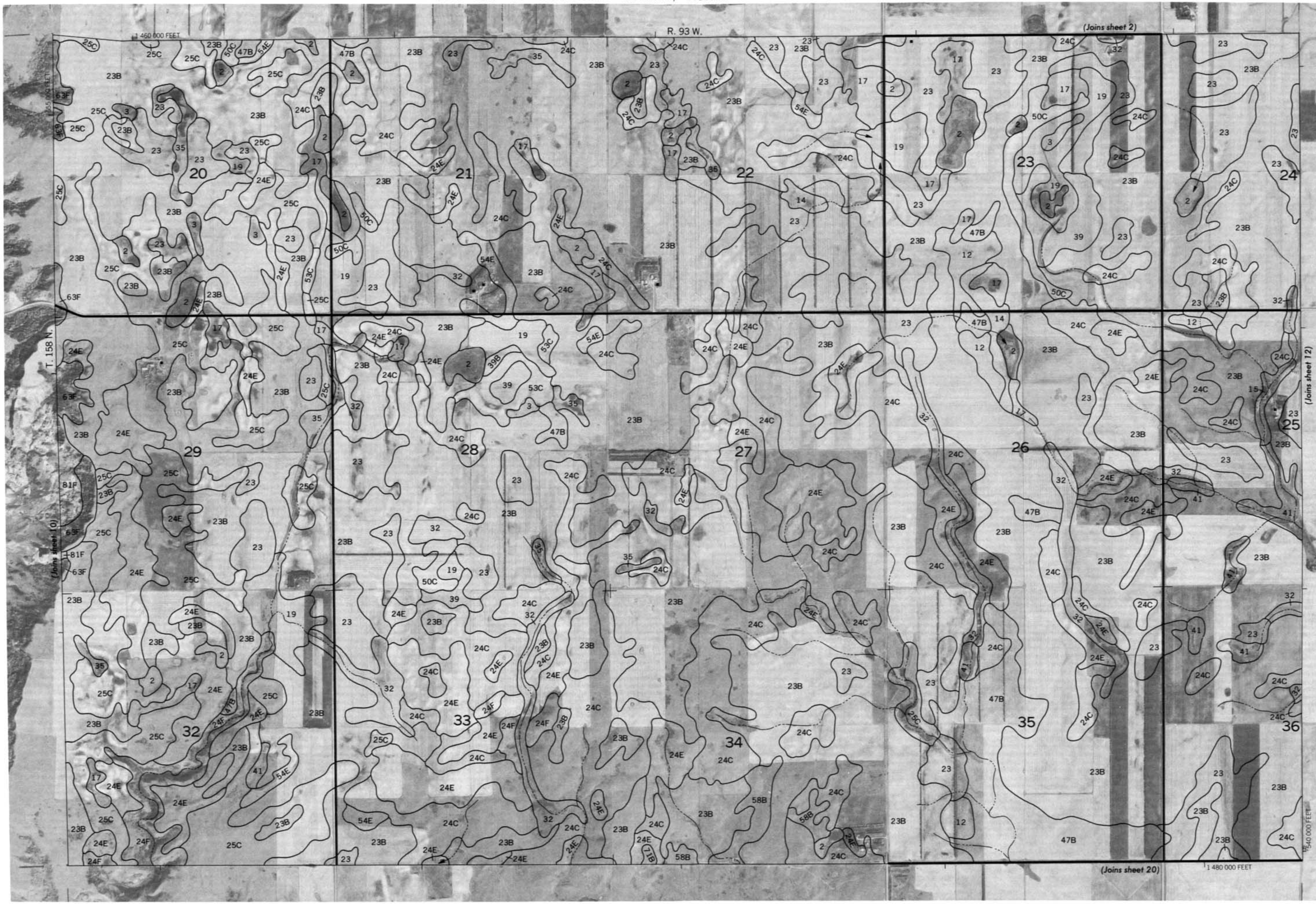
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 9



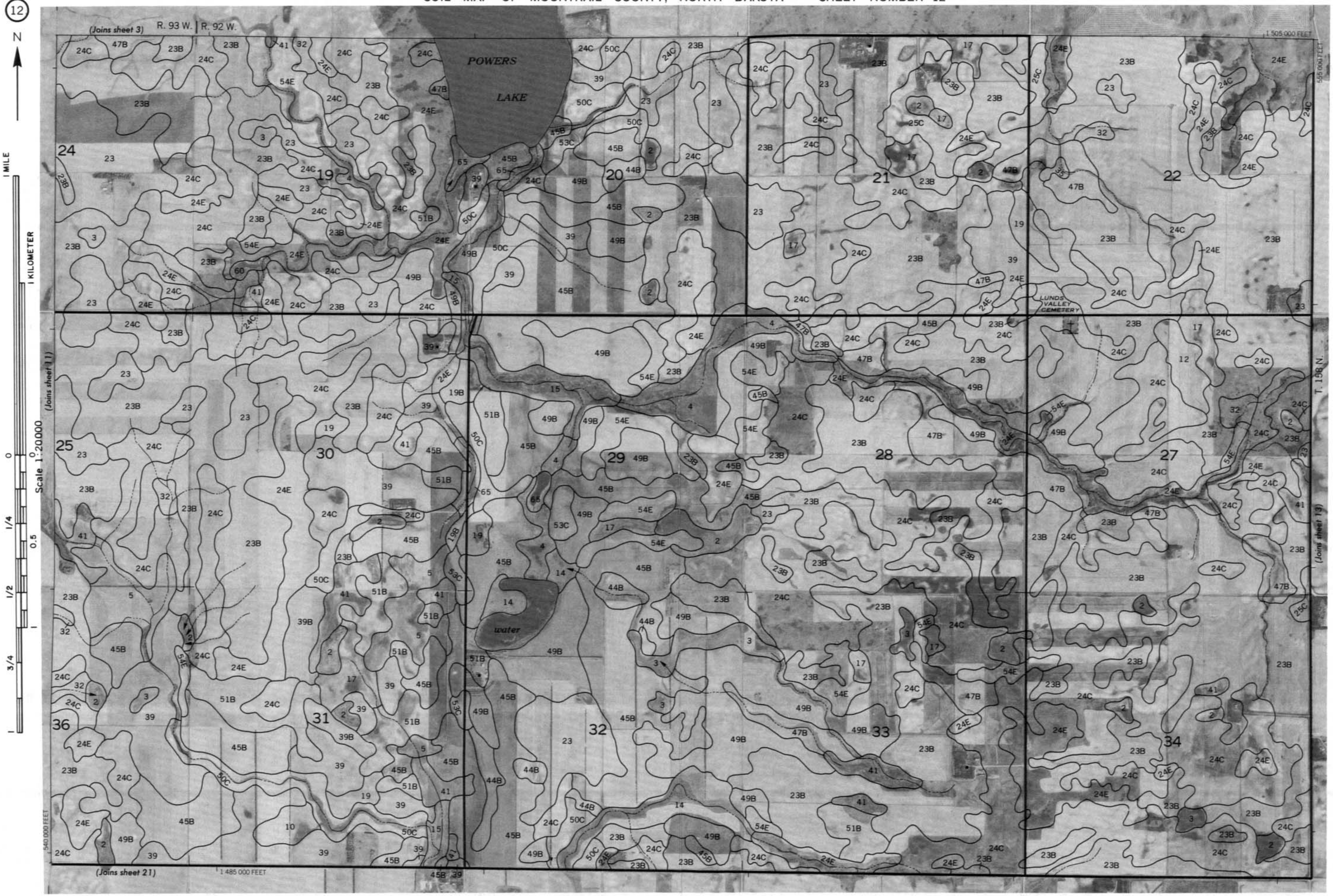
10


N
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 1)
(Joins sheet 19)
(Joins inset, sheet 36)
(Joins sheet 11)
R. 94 W. | R. 93 W.
T. 158 N.
1 455 000 FEET
1 435 000 FEET
545 000 FEET
555 000 FEET
Paulson Creek
LITTLE MUDDY EARTH RIVER
water
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

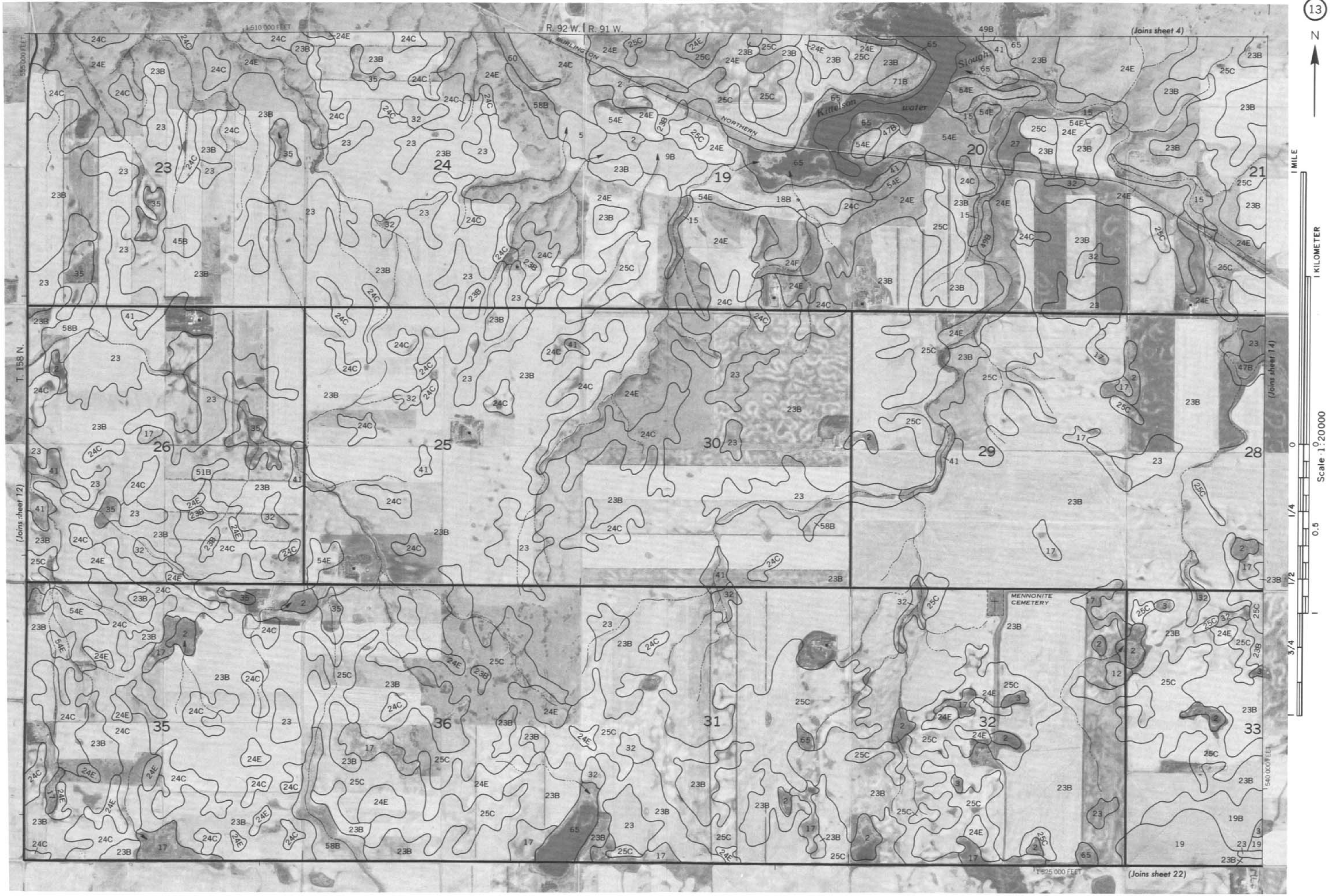
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 11



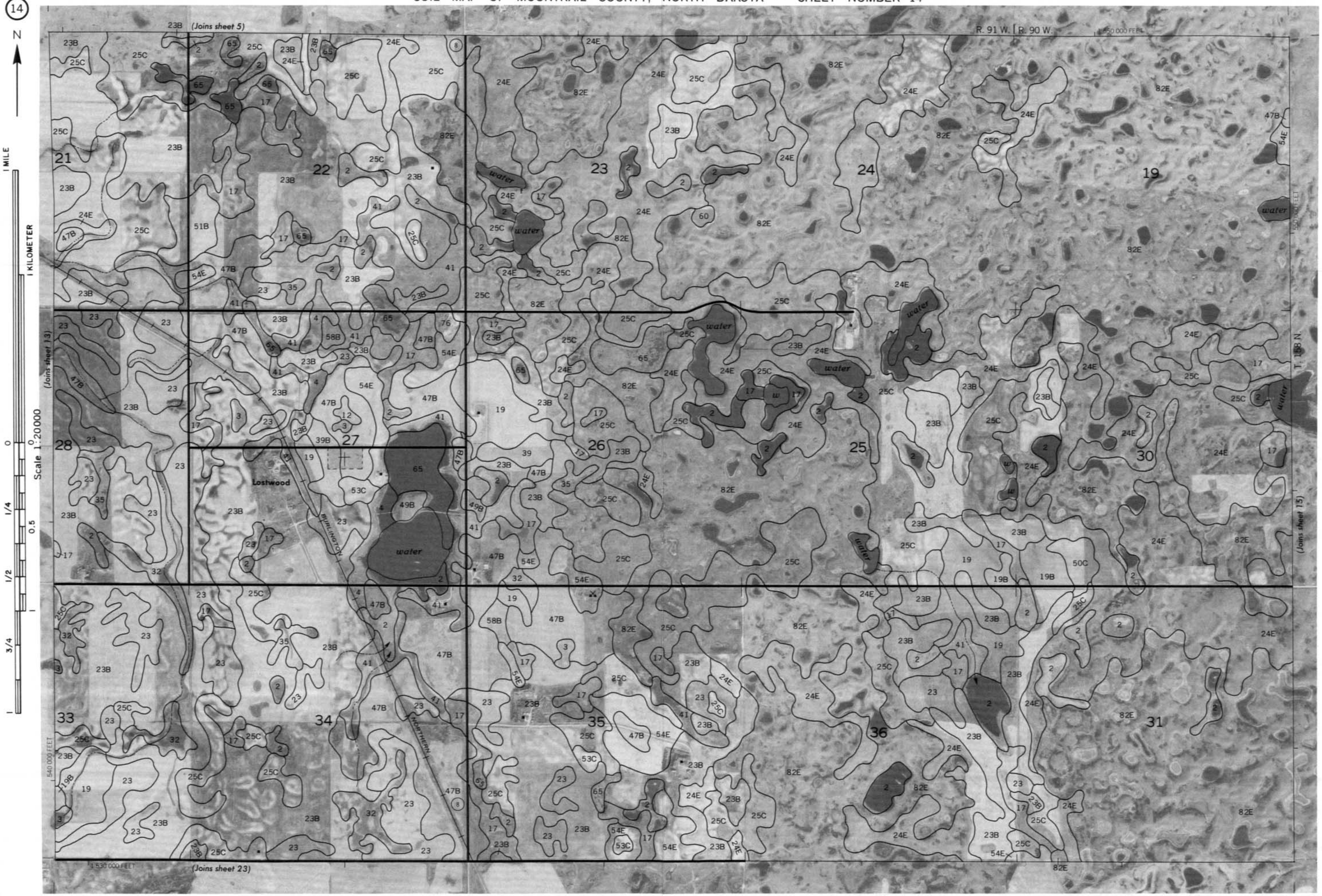
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 12



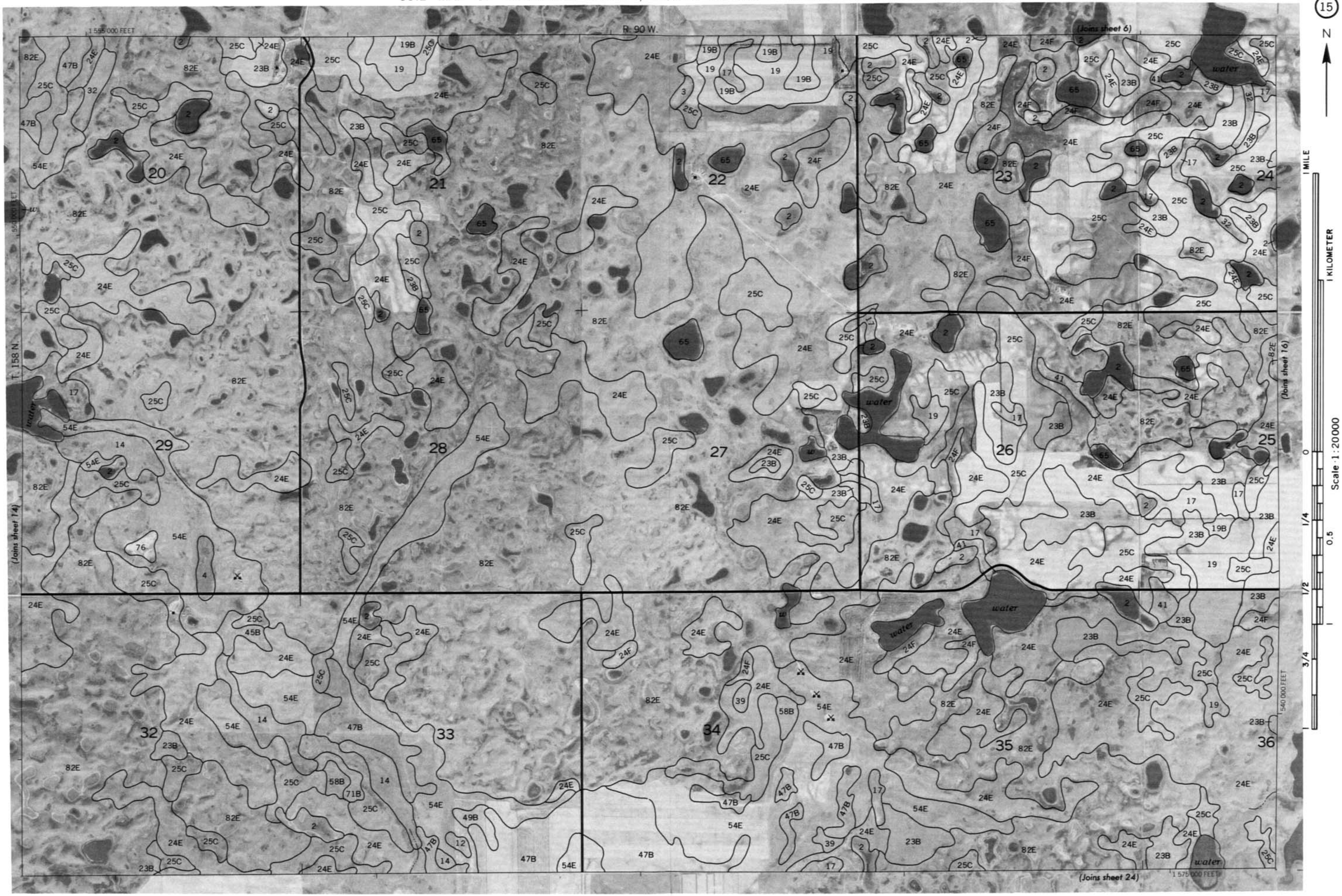
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 13



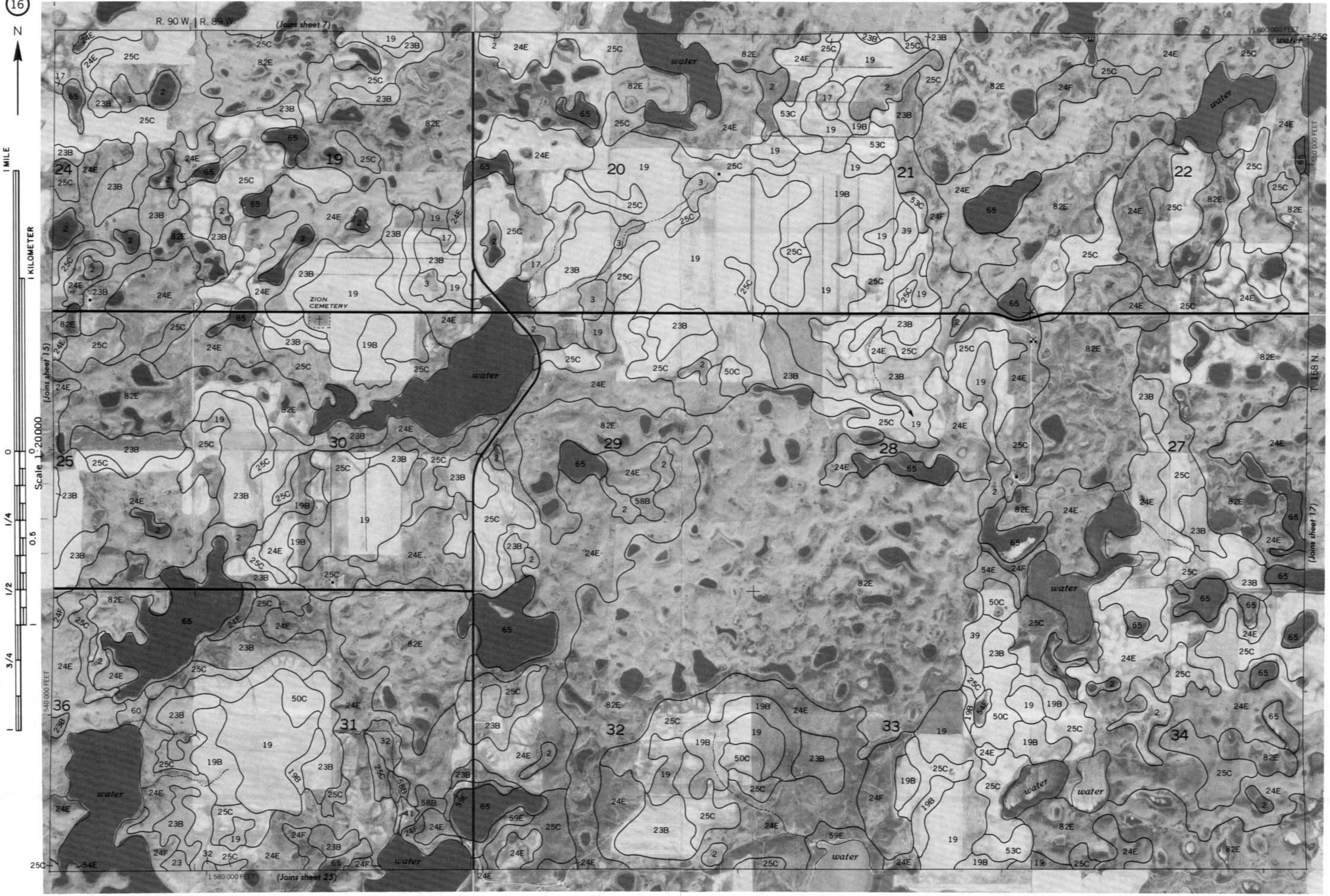
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 14

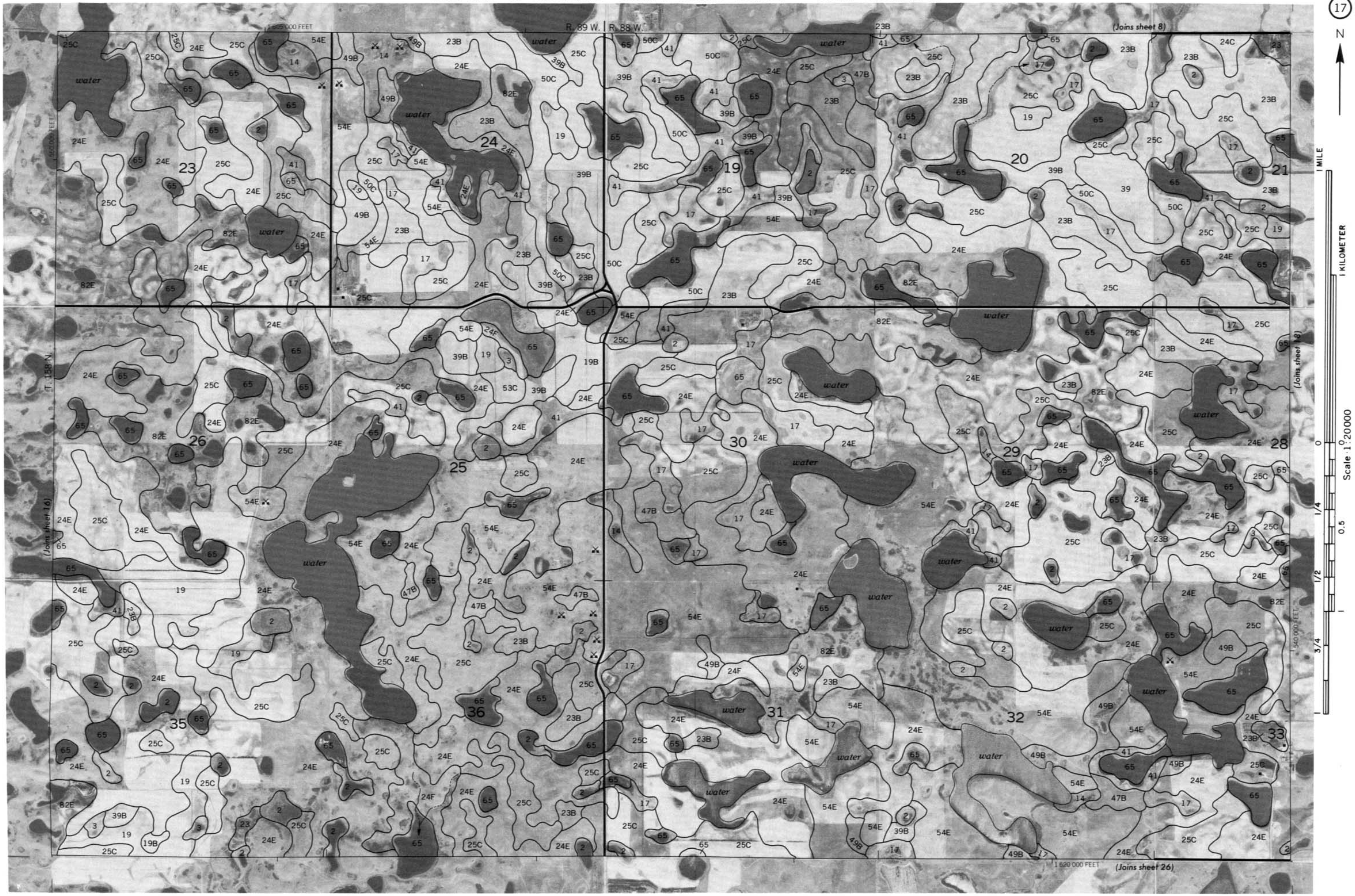


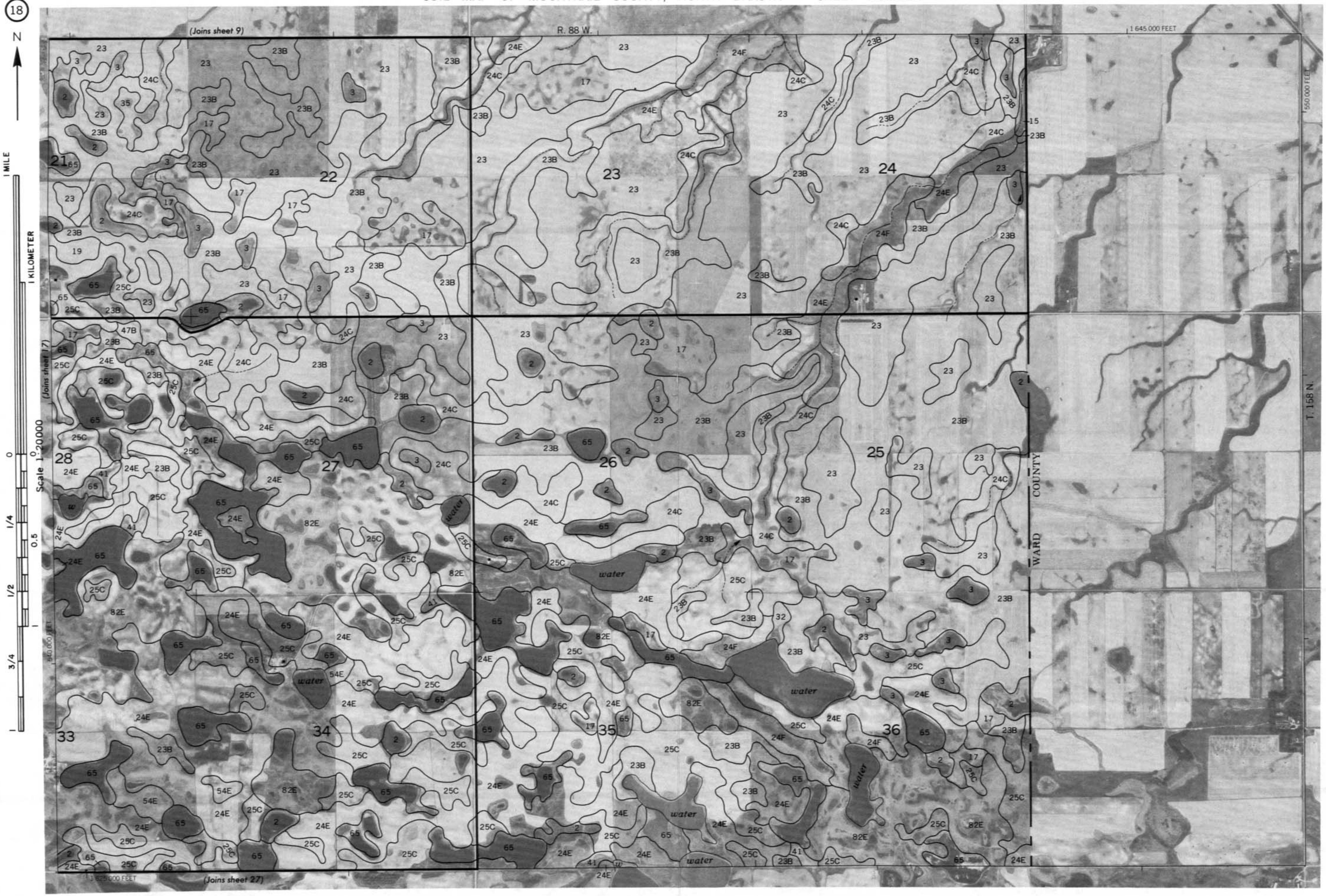
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 15



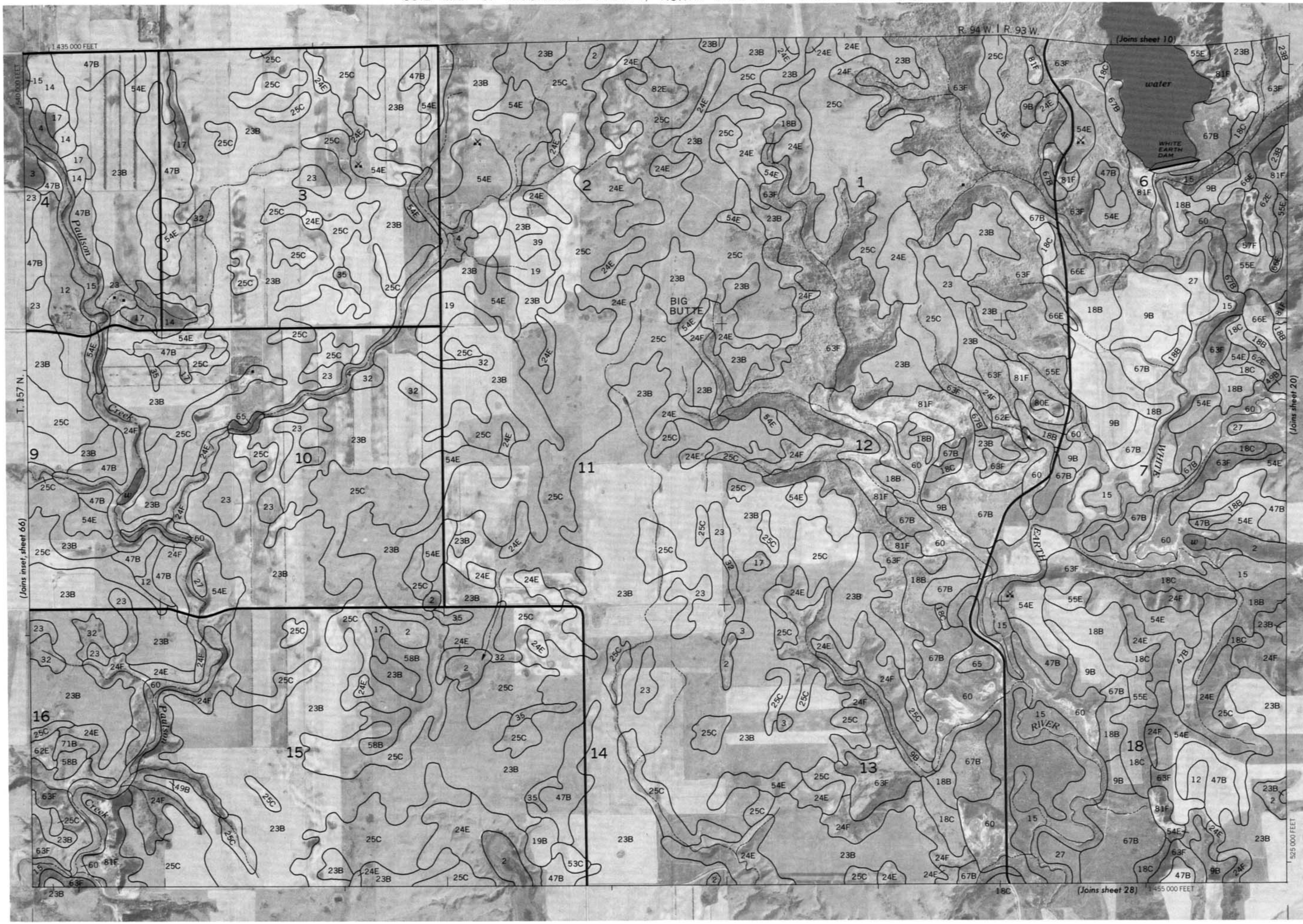
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 16




17
N
R. 89 W. | R. 88 W.
(Joins sheet 8)
(Joins sheet 18)
(Joins sheet 26)
(Joins sheet 16)
T. 158 N.
1 605 000 FEET
1 620 000 FEET
550 000 FEET
540 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

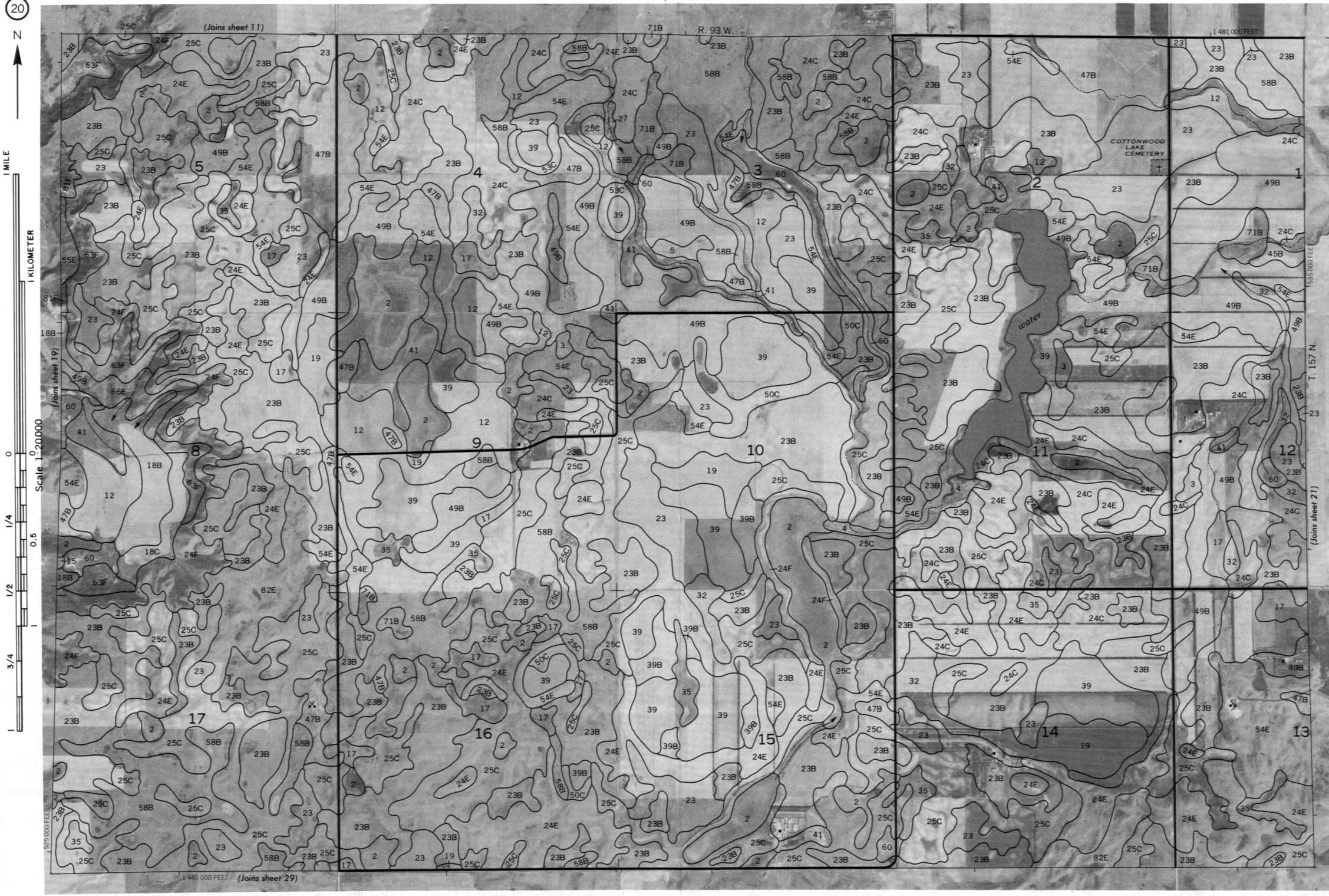

18
N
(Joins sheet 9)
R. 88 W.
1 645 000 FEET
550 000 FEET
T. 158 N.
(Joins sheet 17)
(Joins sheet 27)
WARD COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
21
22
23
24
25
26
27
28
33
34
35
36

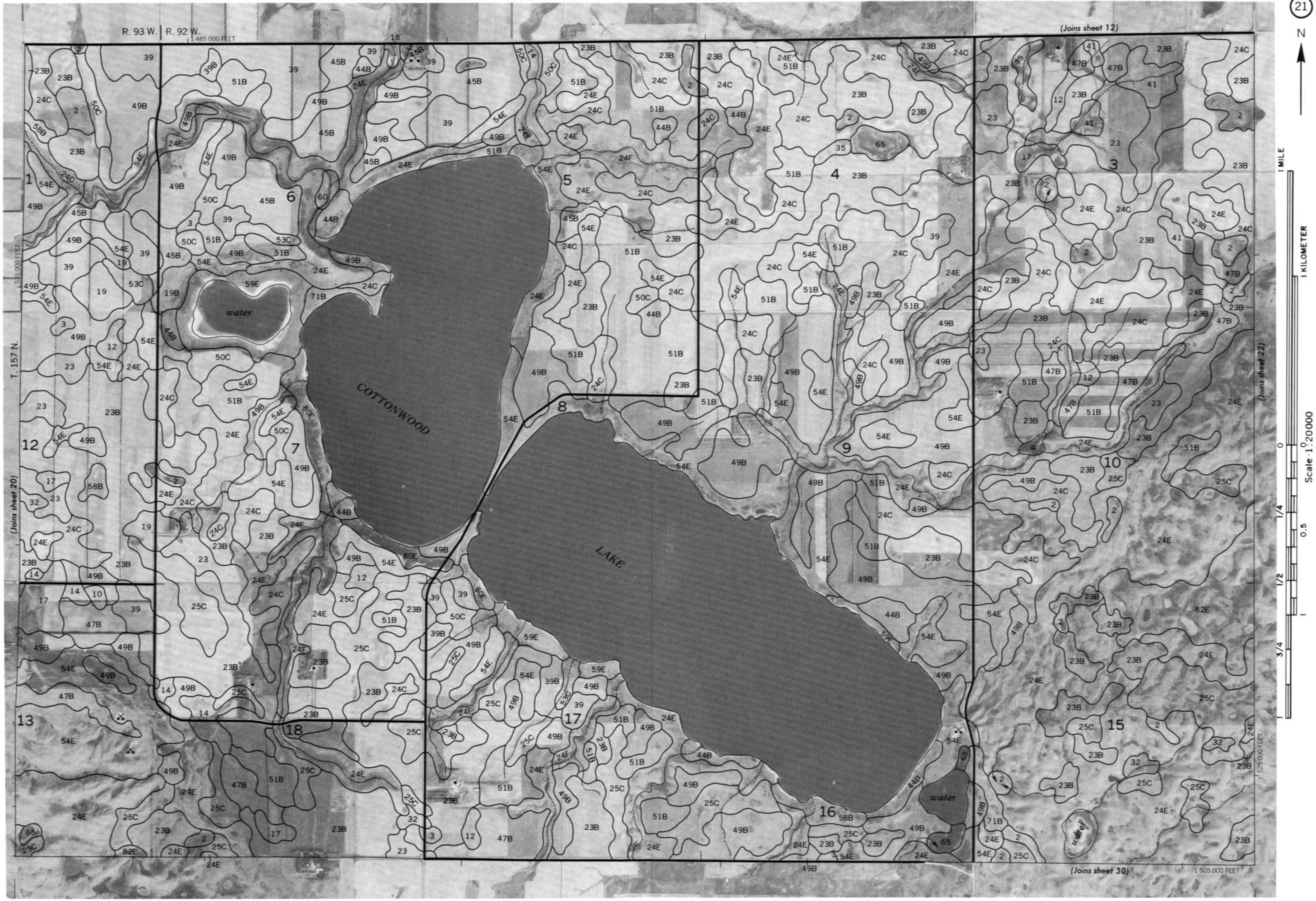
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 19



20

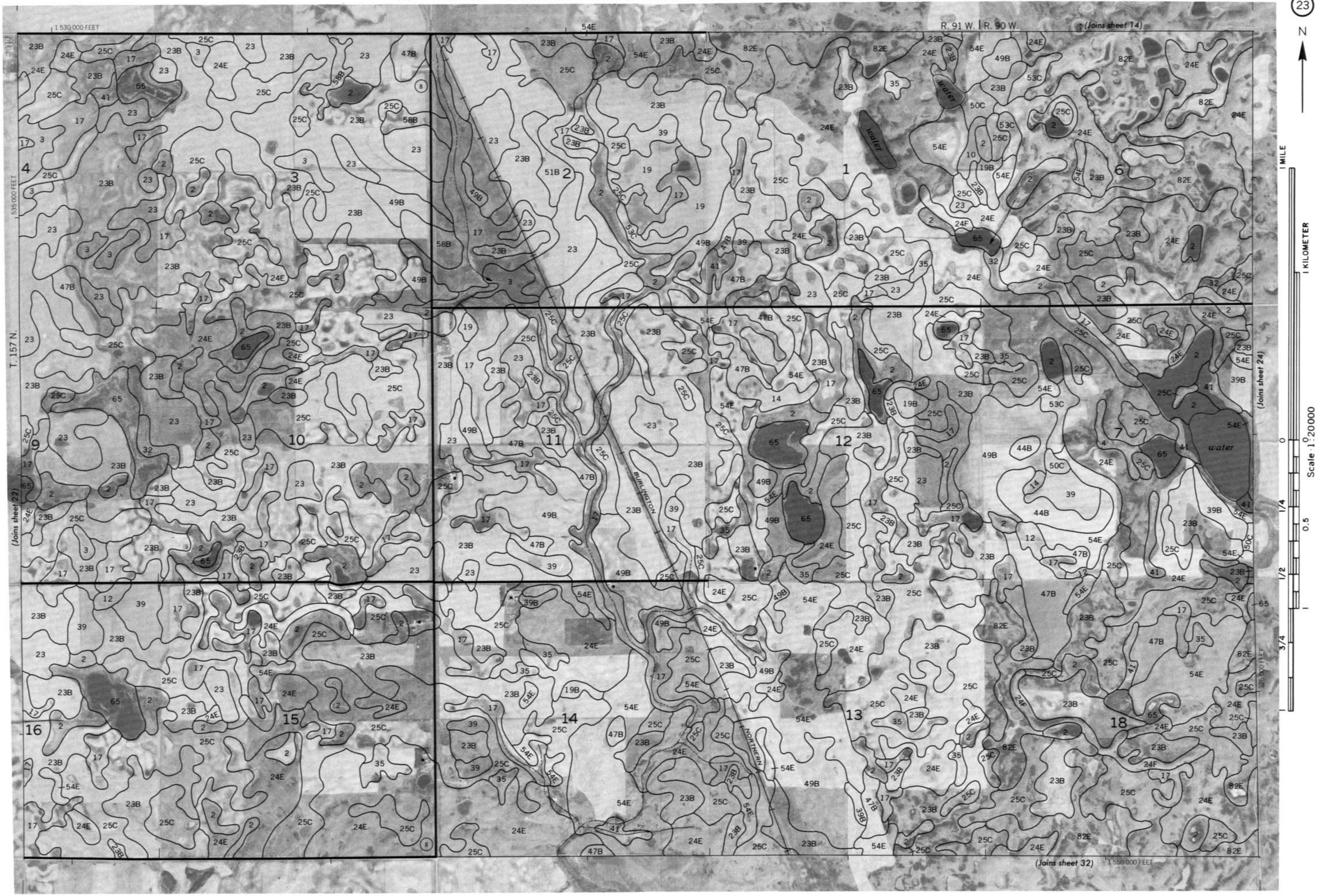
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 20




R. 93 W.
R. 92 W.
1 485 000 FEET
(Joins sheet 12)
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 30)
T. 157 N.
535 000 FEET
525 000 FEET
1 505 000 FEET
COTTONWOOD
LAKE
water
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1

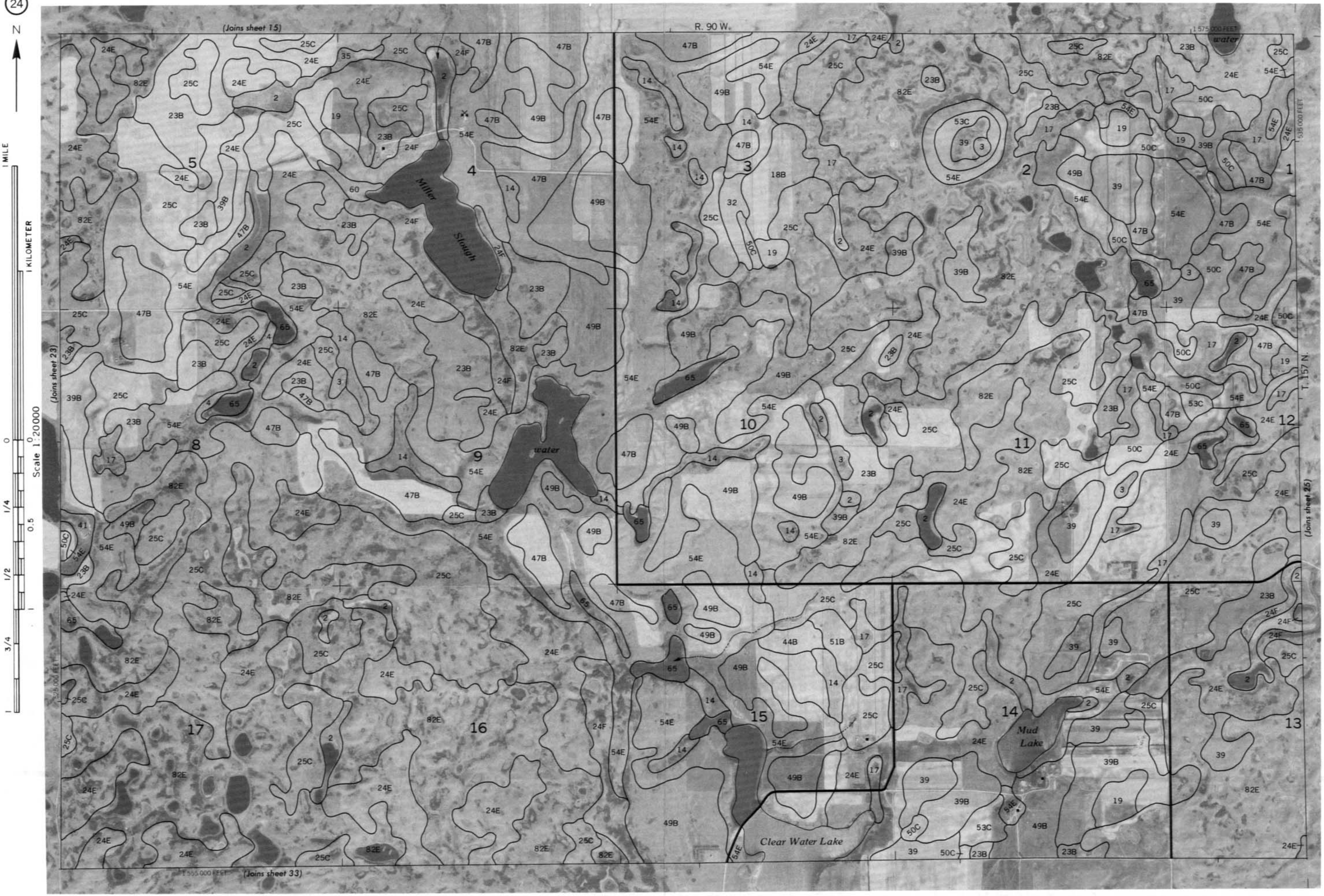
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 22

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 23

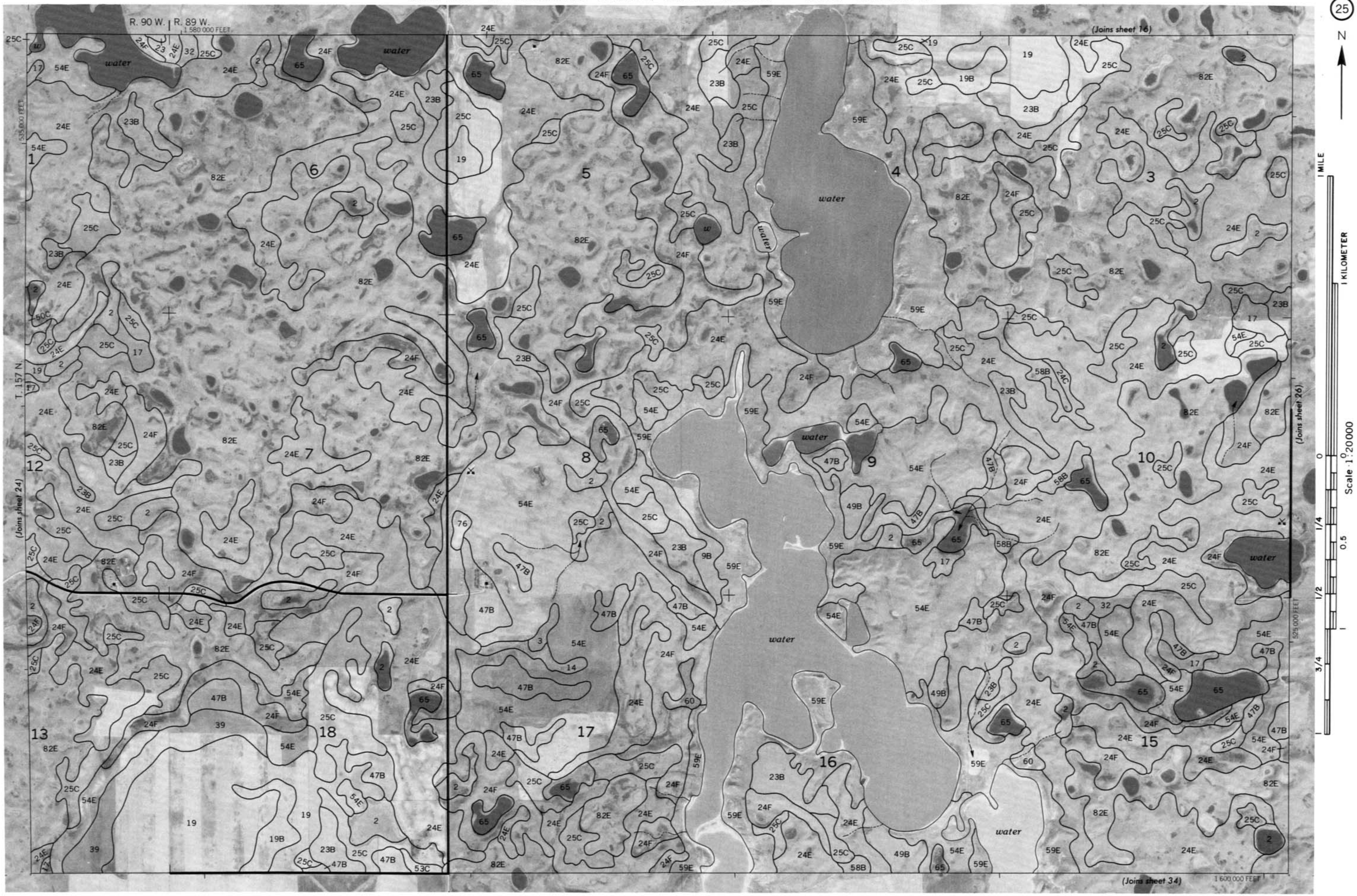


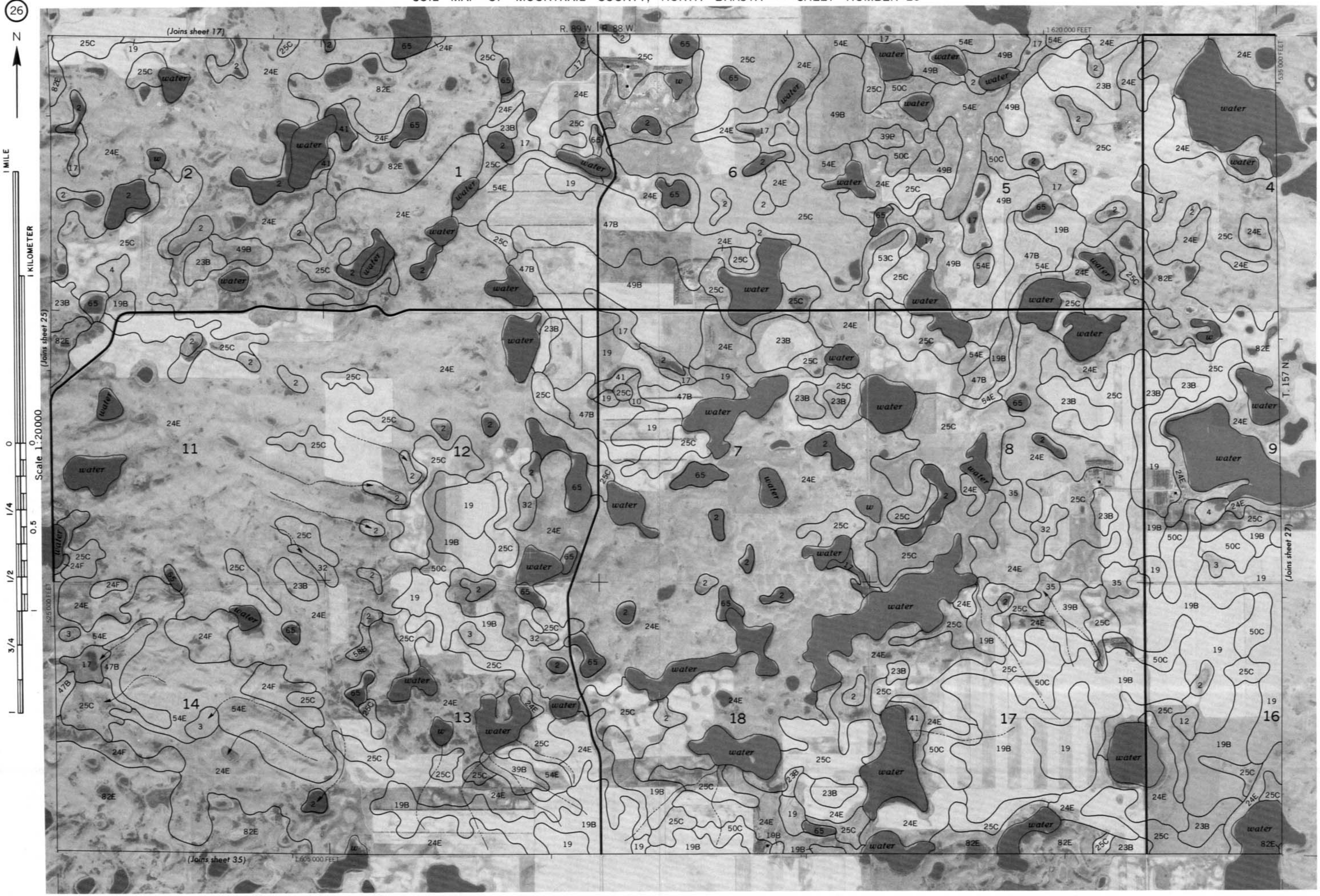
24

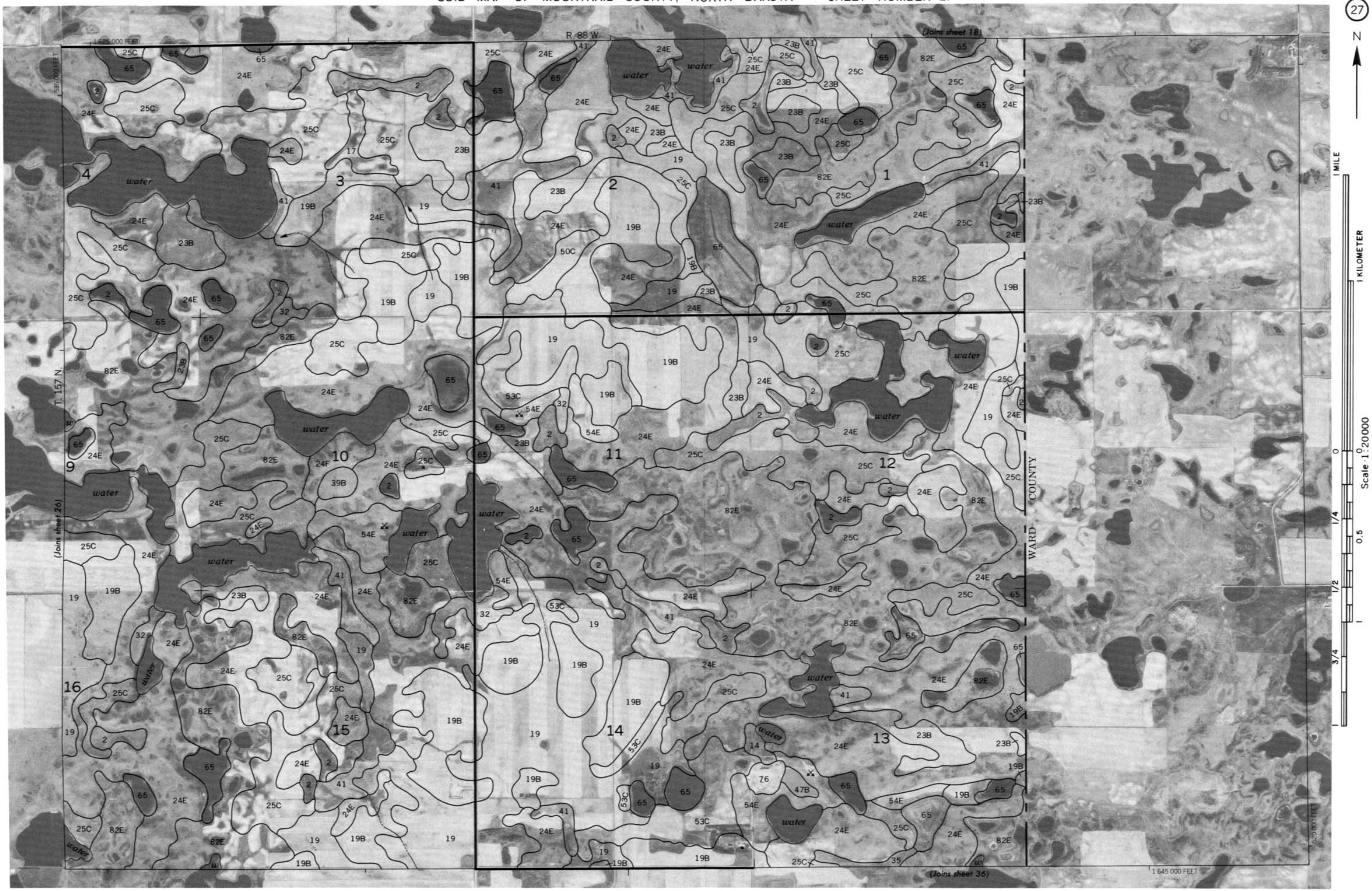
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 24



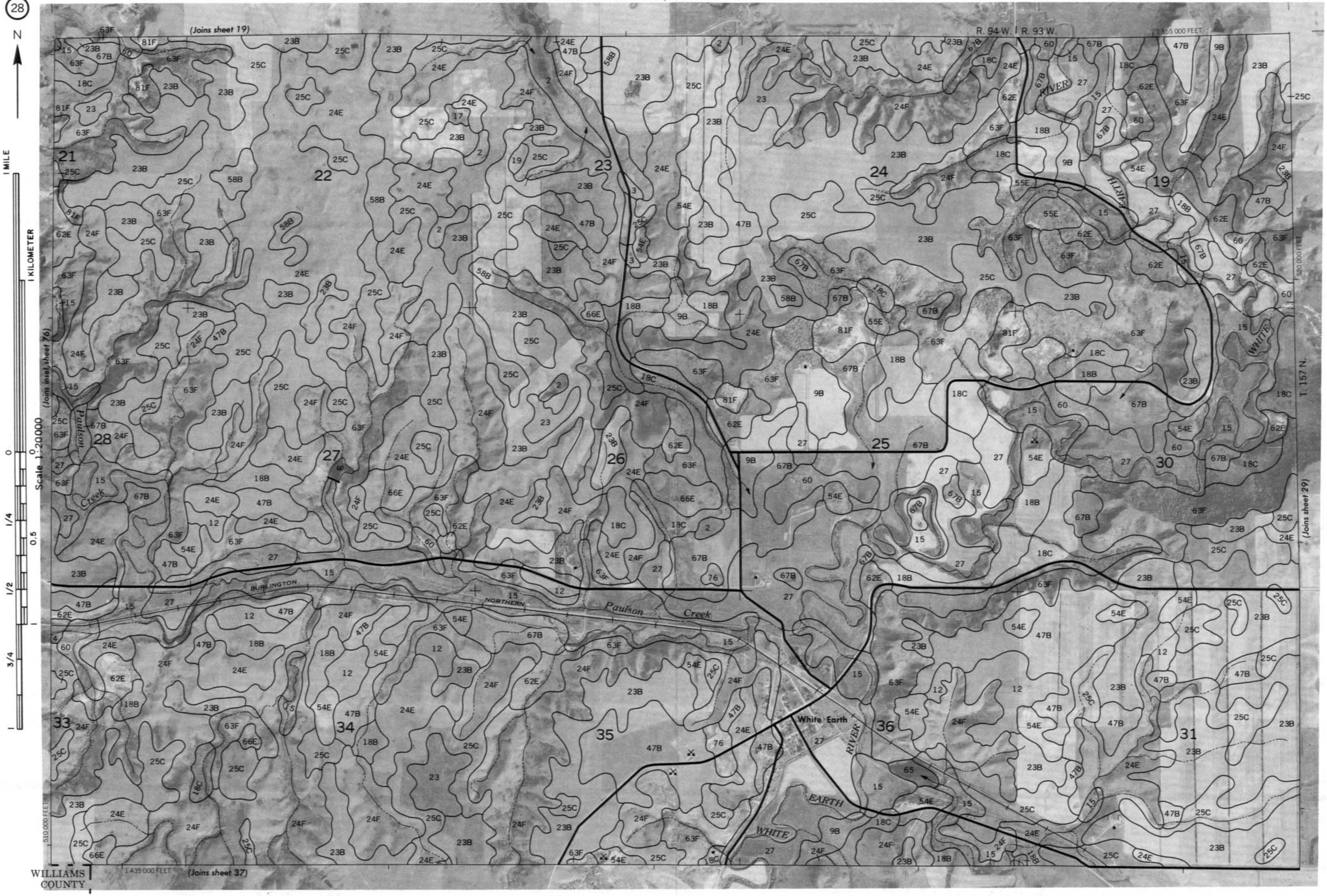
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 25



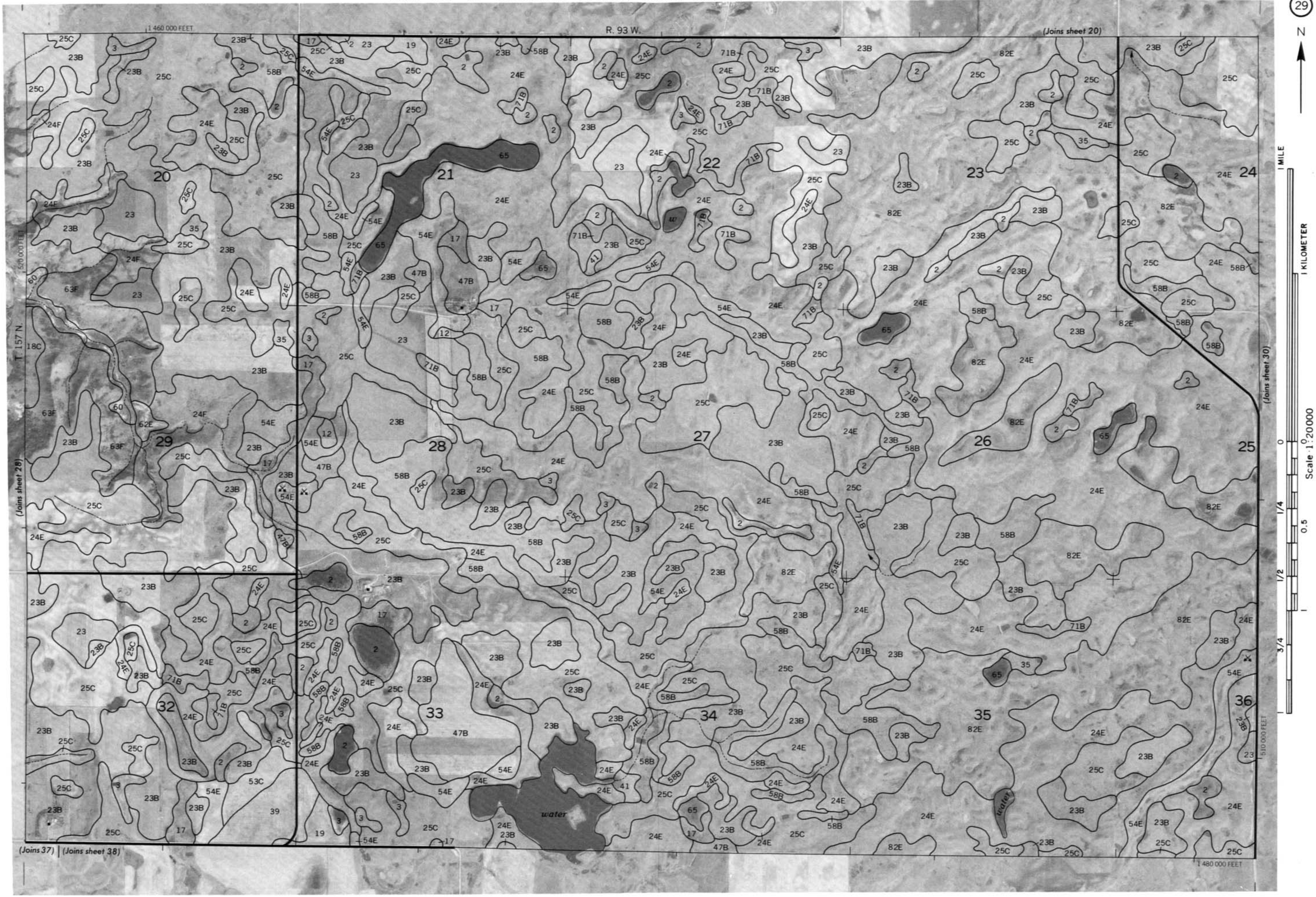

26
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 17)
R. 89 W.
R. 88 W.
1 620 000 FEET
535 000 FEET
(Joins sheet 25)
T. 157 N.
(Joins sheet 27)
525 000 FEET
(Joins sheet 35)
1 605 000 FEET


27
N
R. 88 W.
(Joins sheet 18)
(Joins sheet 26)
(Joins sheet 36)
T. 157 N.
WARD COUNTY
1 625 000 FEET
1 645 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
water

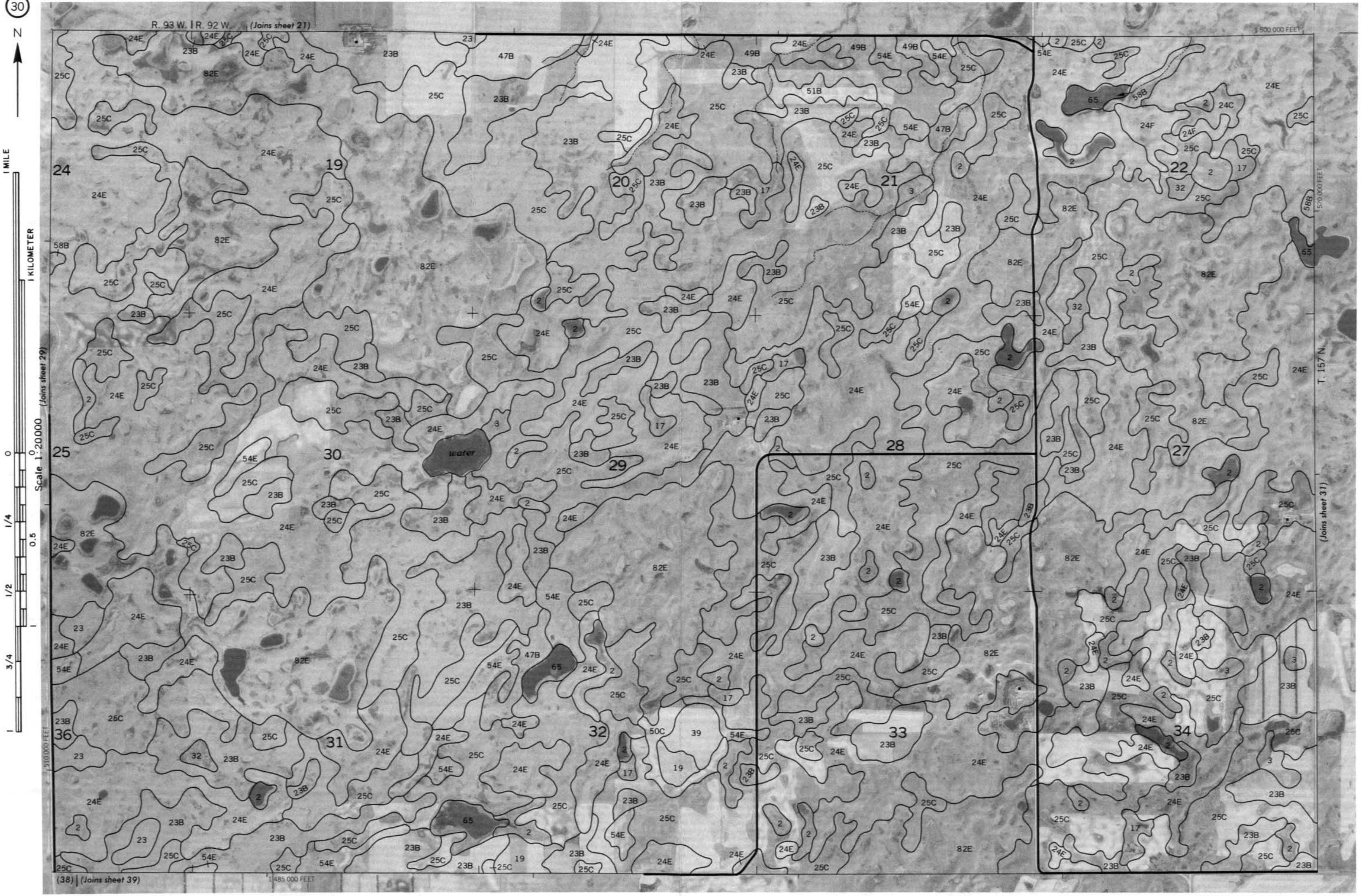
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 28

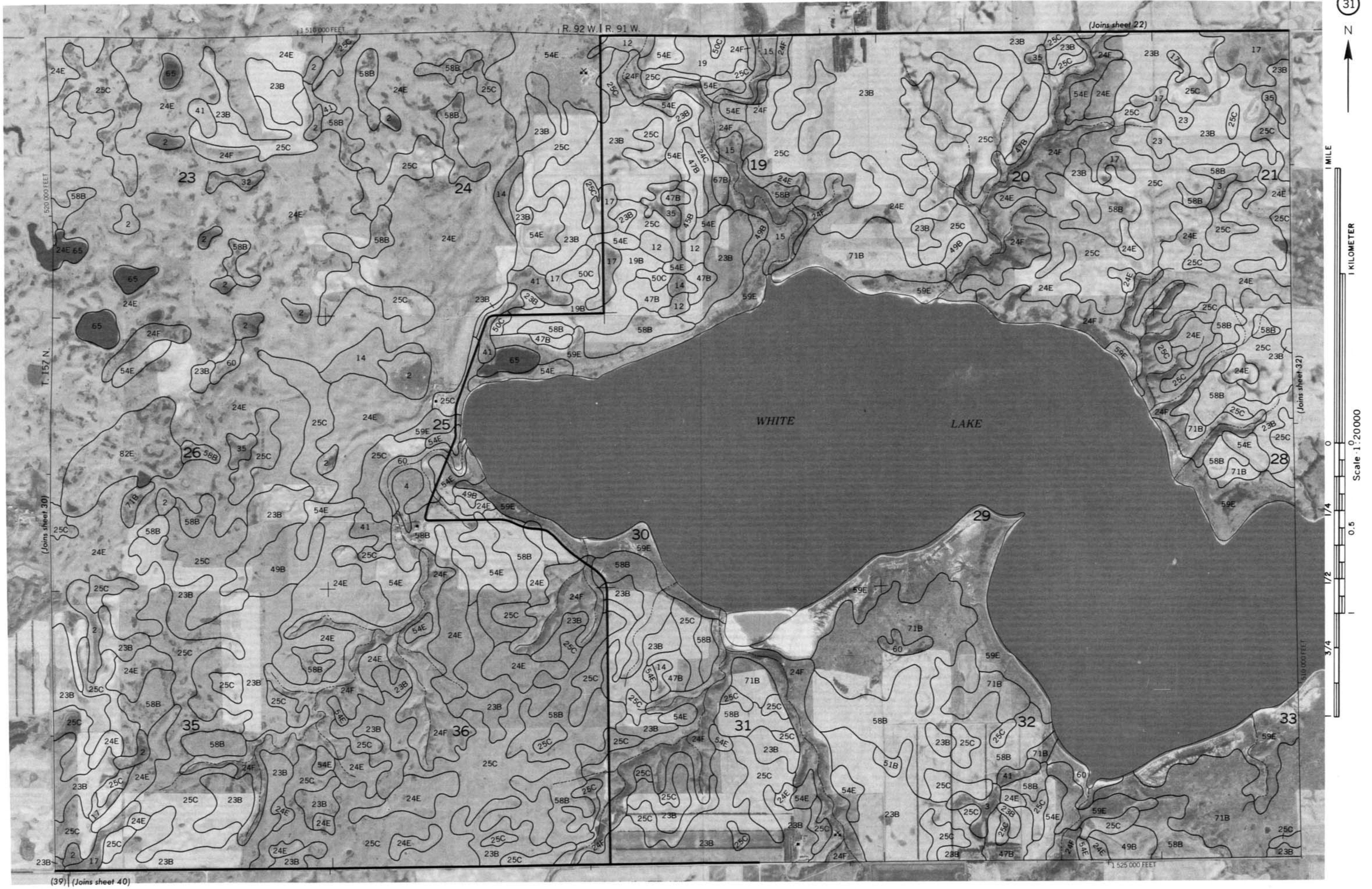


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 29



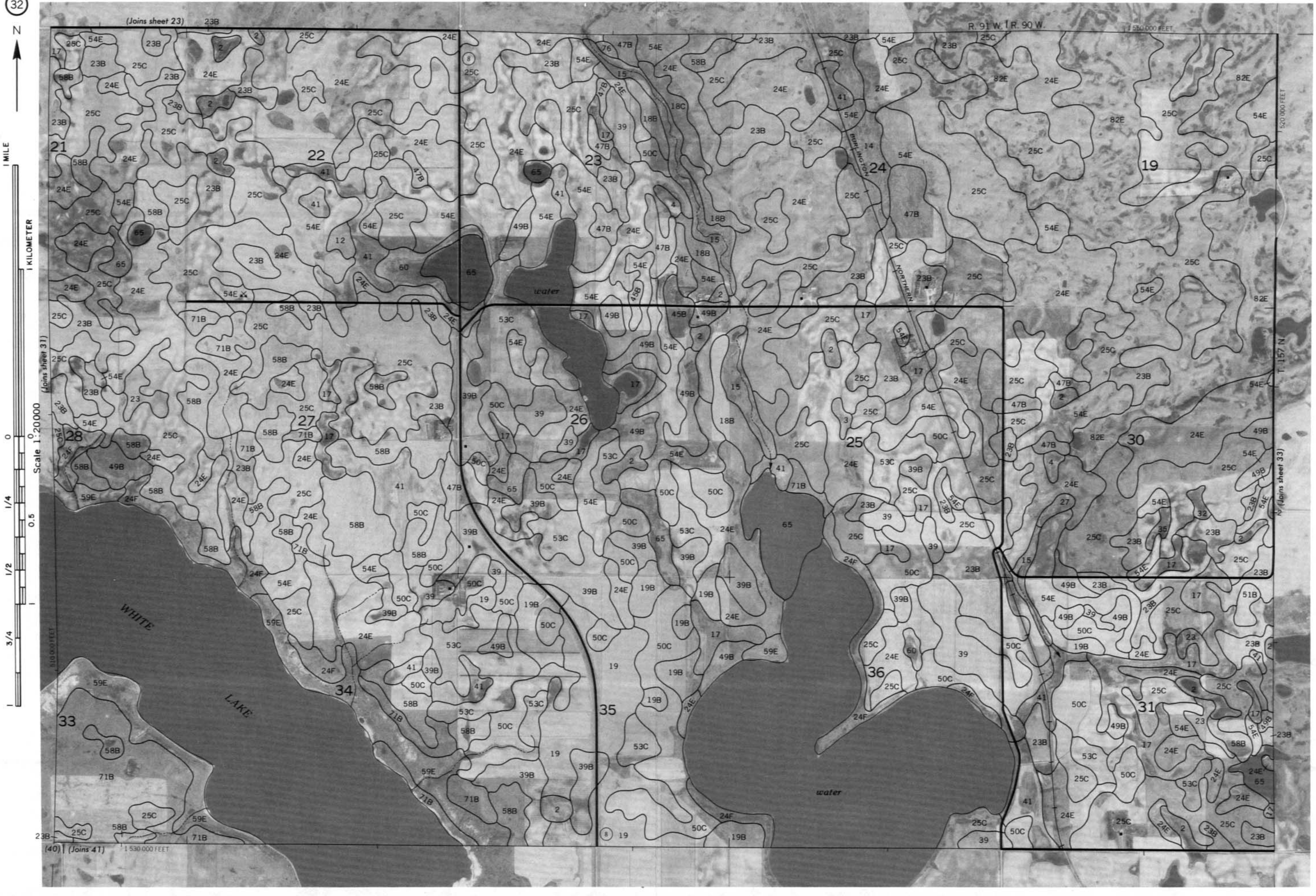
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 30




R. 92 W. | R. 91 W.
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 32)
(39) (Joins sheet 40)
T. 157 N.
1 510 000 FEET
520 000 FEET
1 525 000 FEET
510 000 FEET
WHITE
LAKE
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

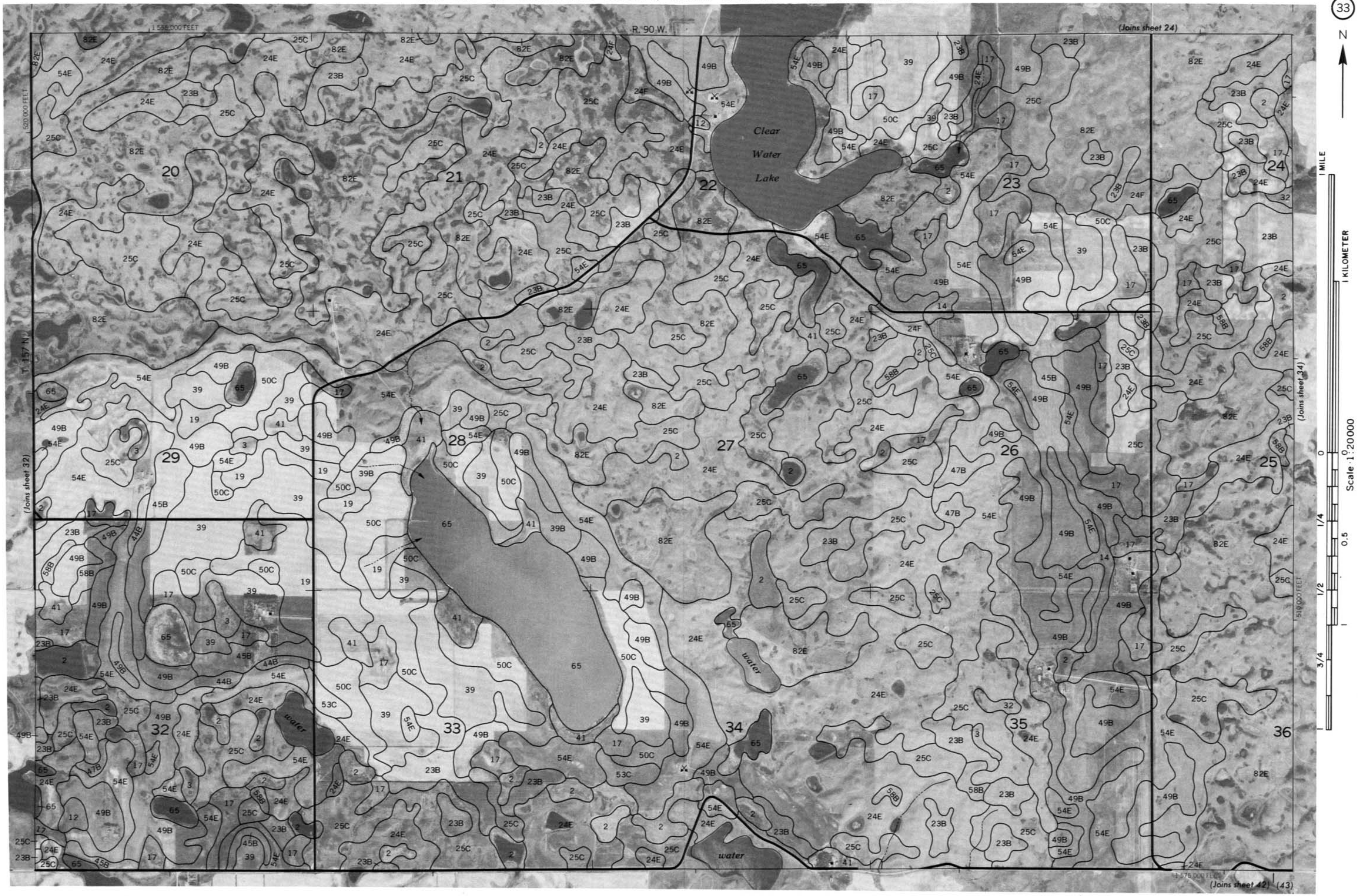
32

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 32

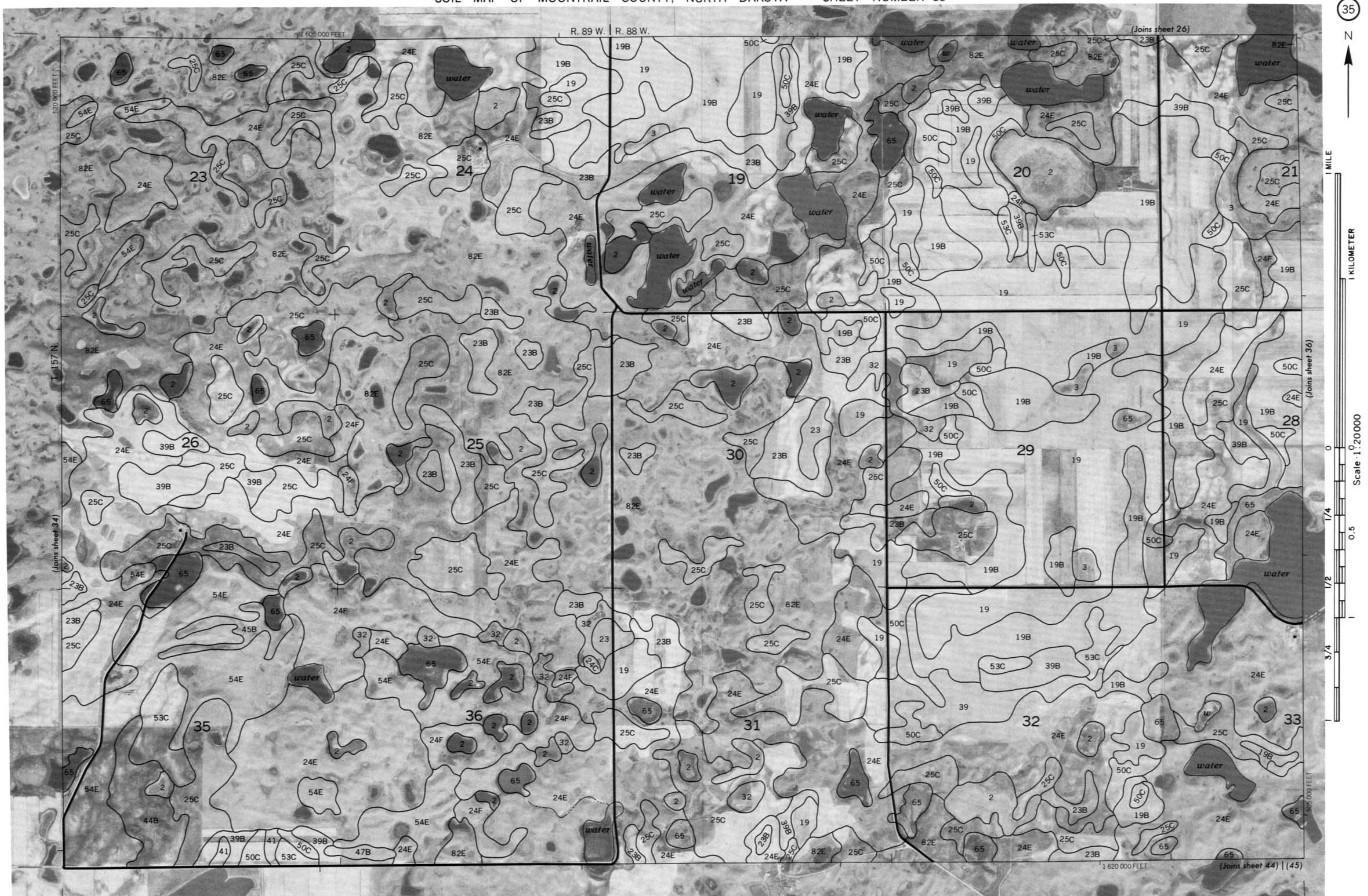


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 33

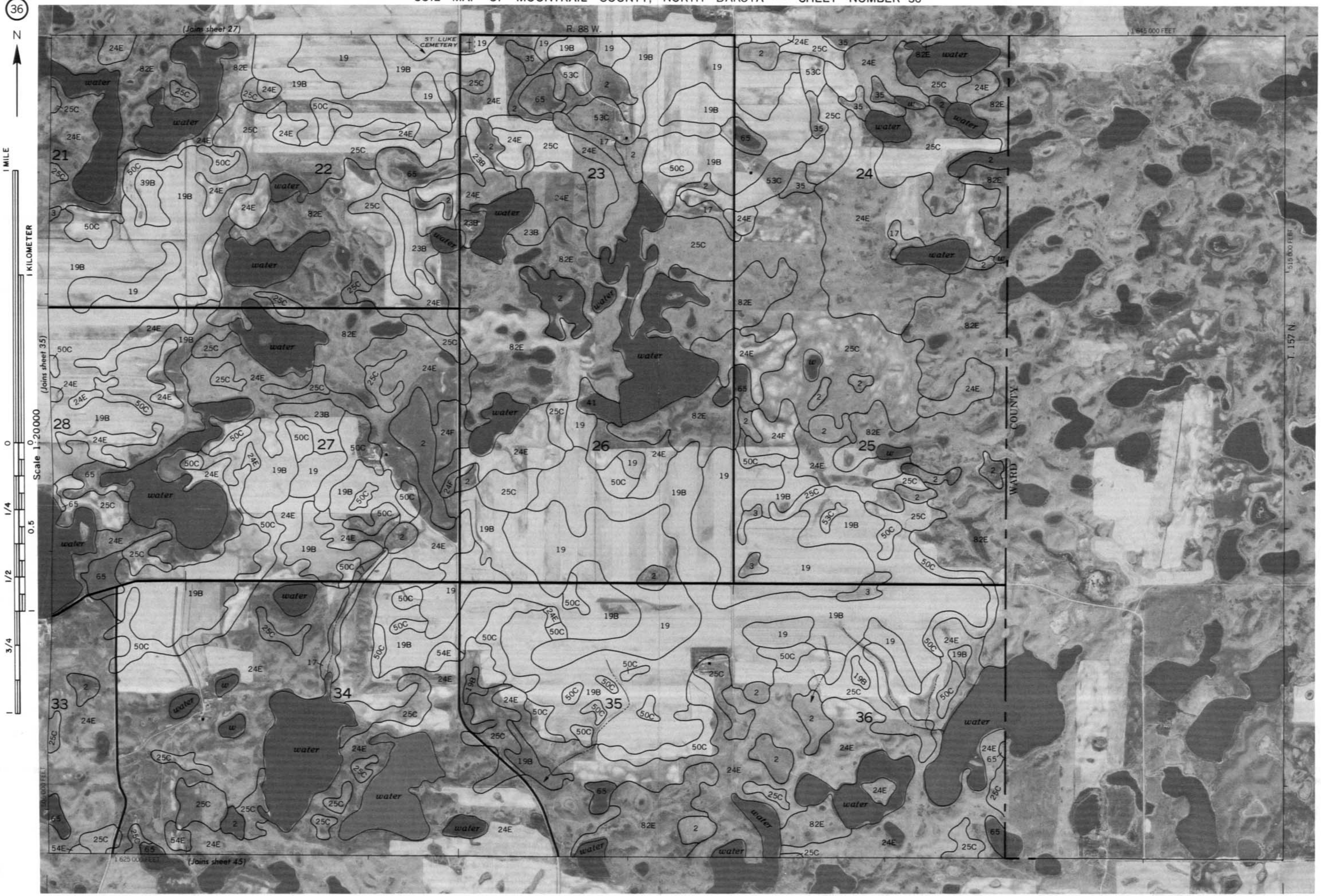
33



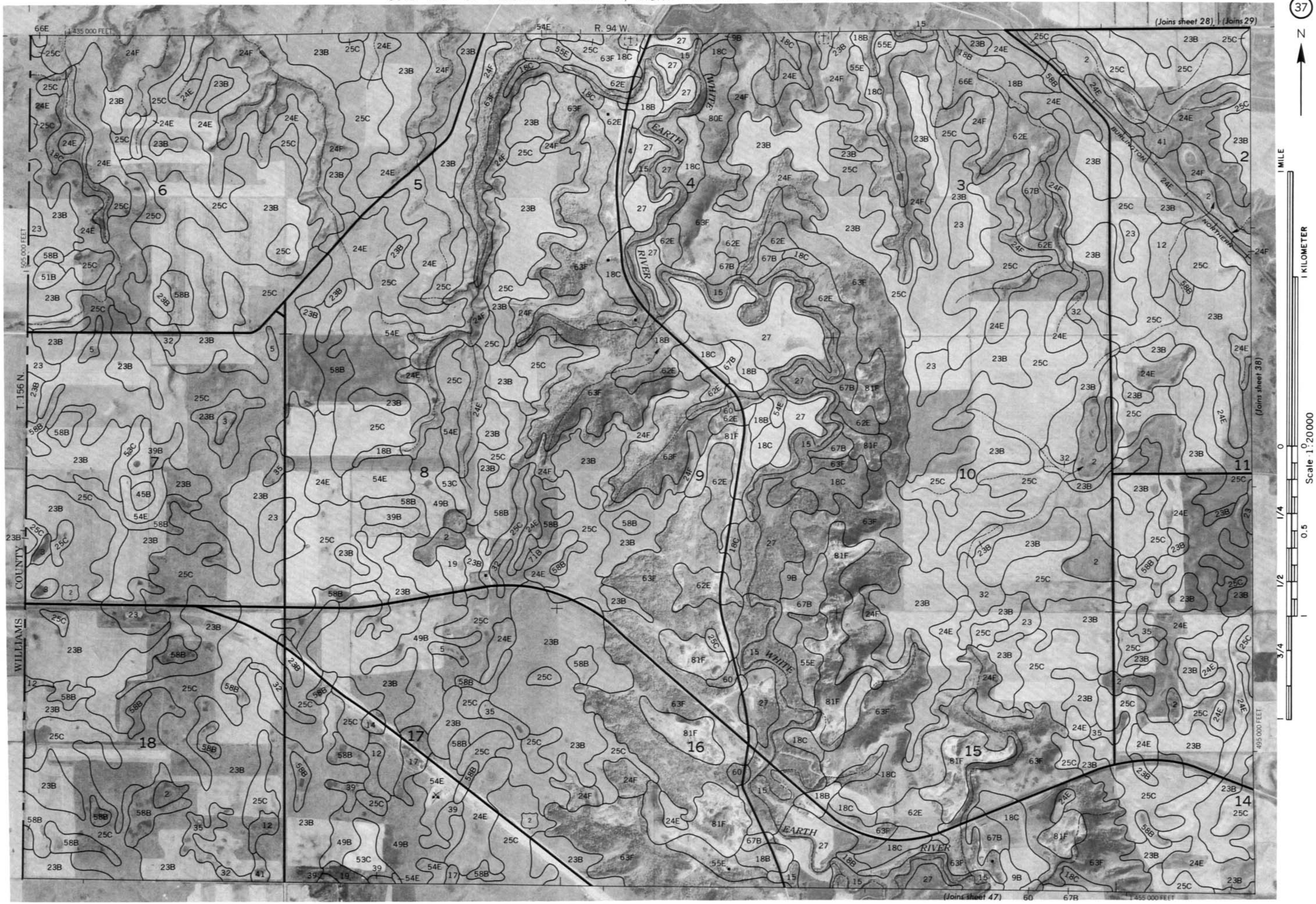
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 34


35
N
R. 89 W. | R. 88 W.
(Joins sheet 26)
(Joins sheet 36)
(Joins sheet 34)
(Joins sheet 44) | (45)
T. 157 N.
1 605 000 FEET
520 000 FEET
1 620 000 FEET
505 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
water

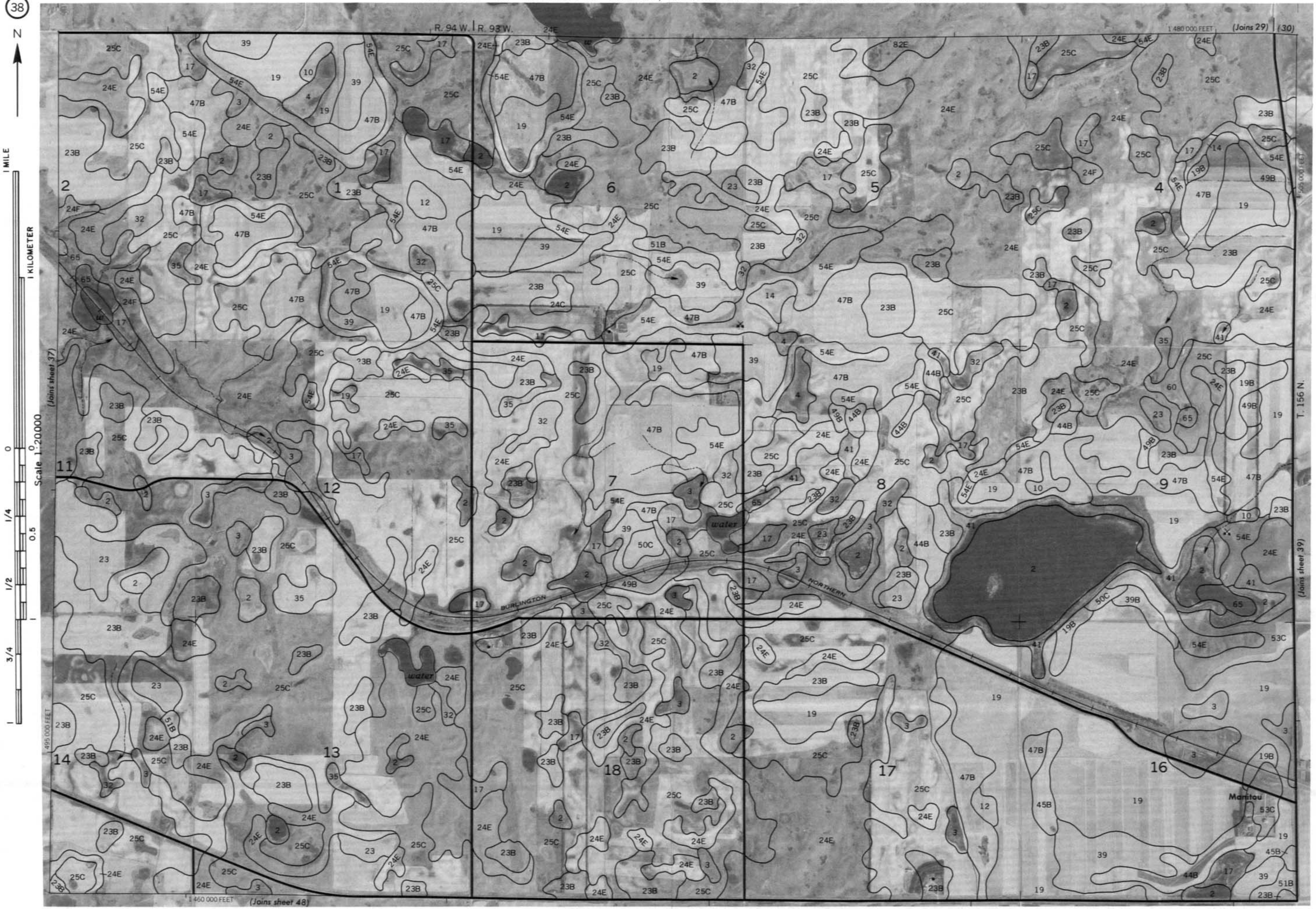
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 36



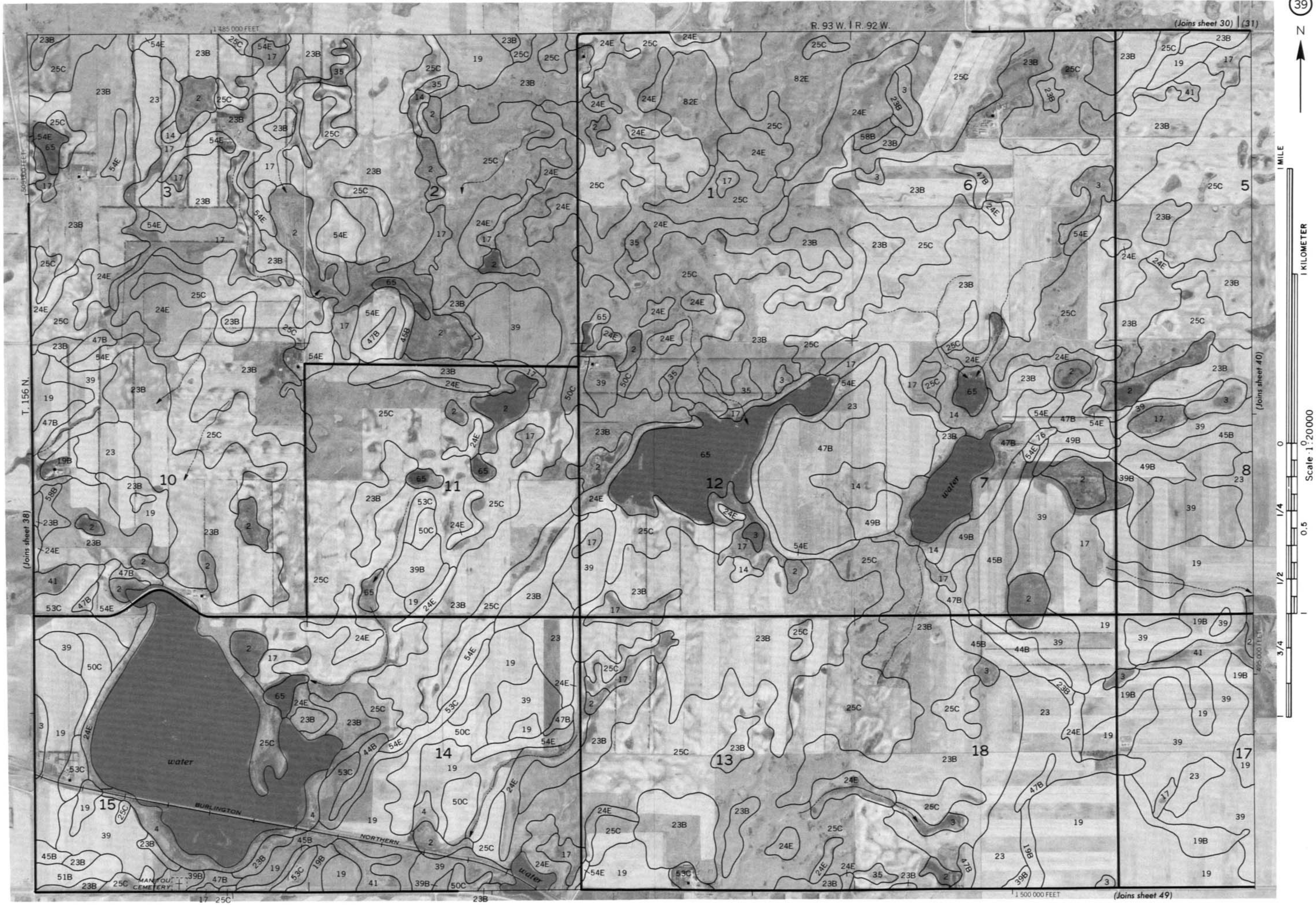
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 37



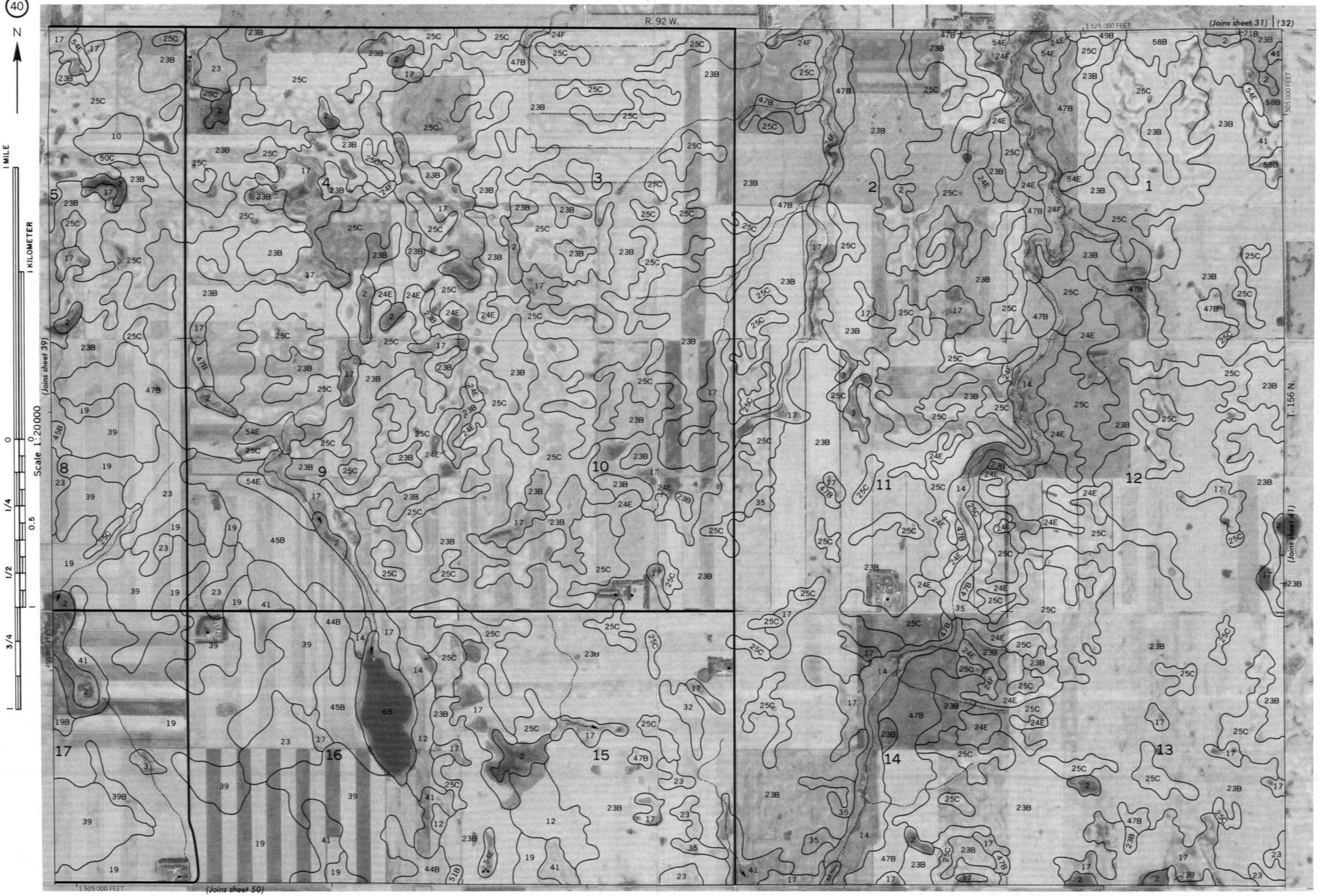
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 38



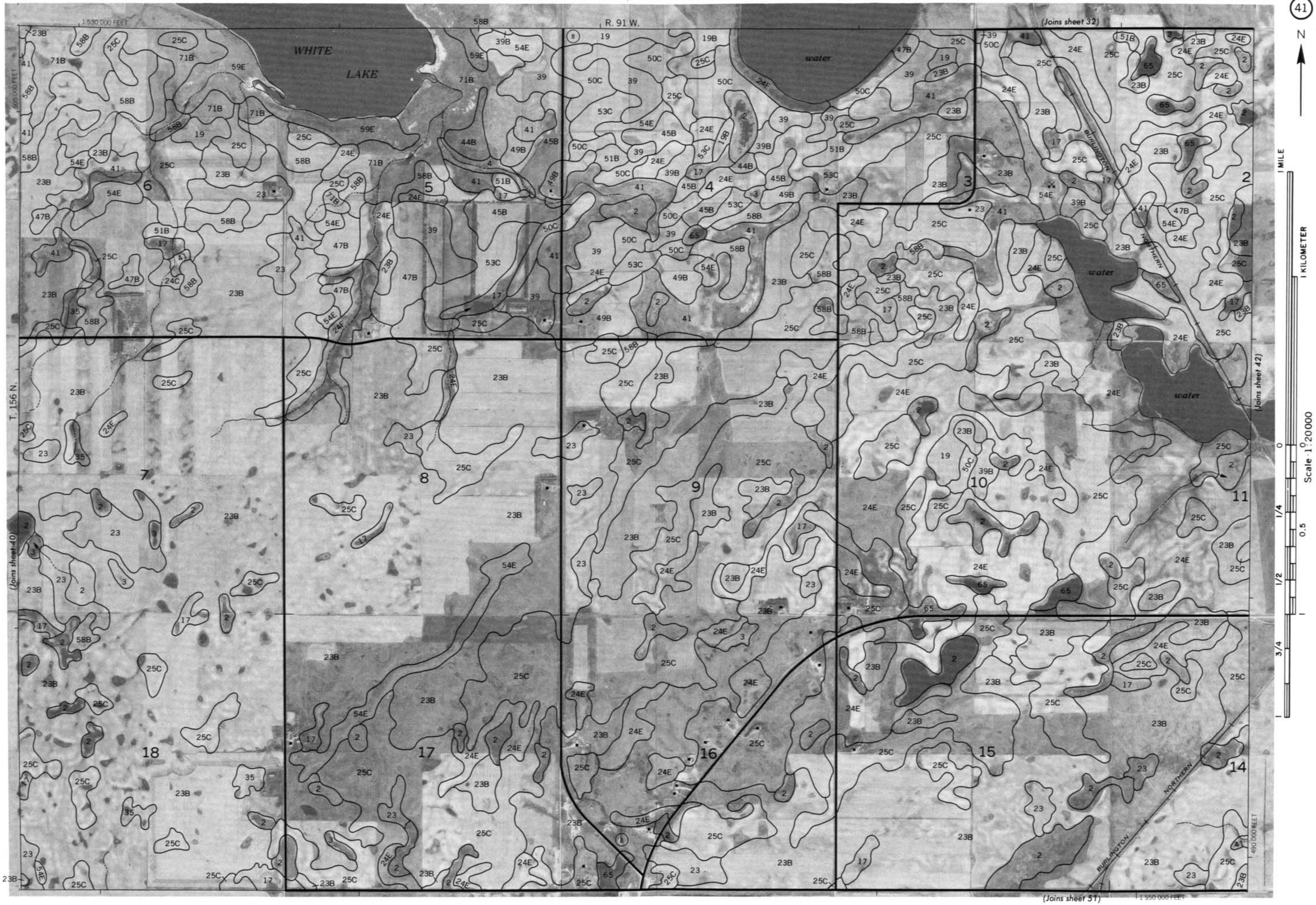
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 39

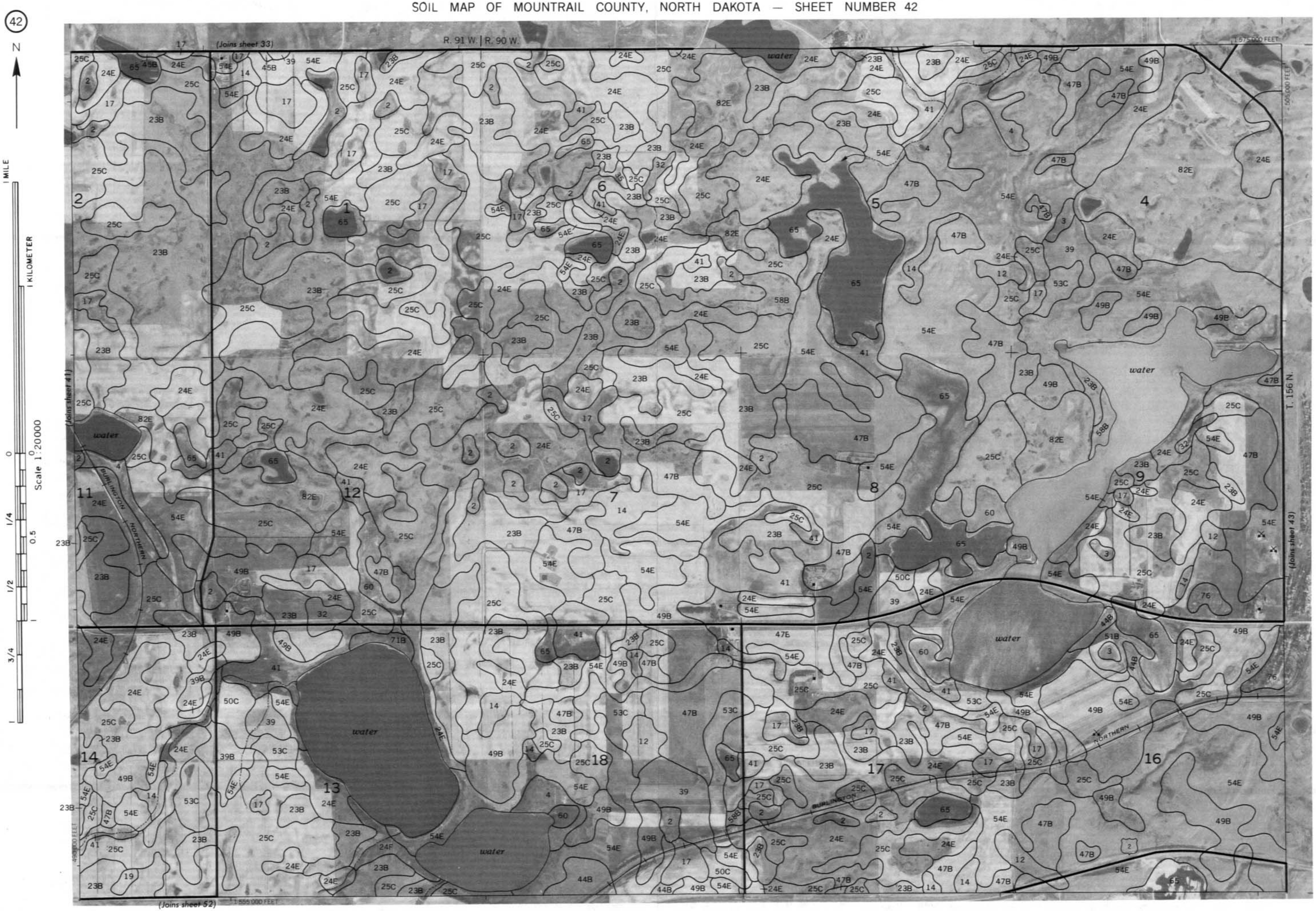


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 40

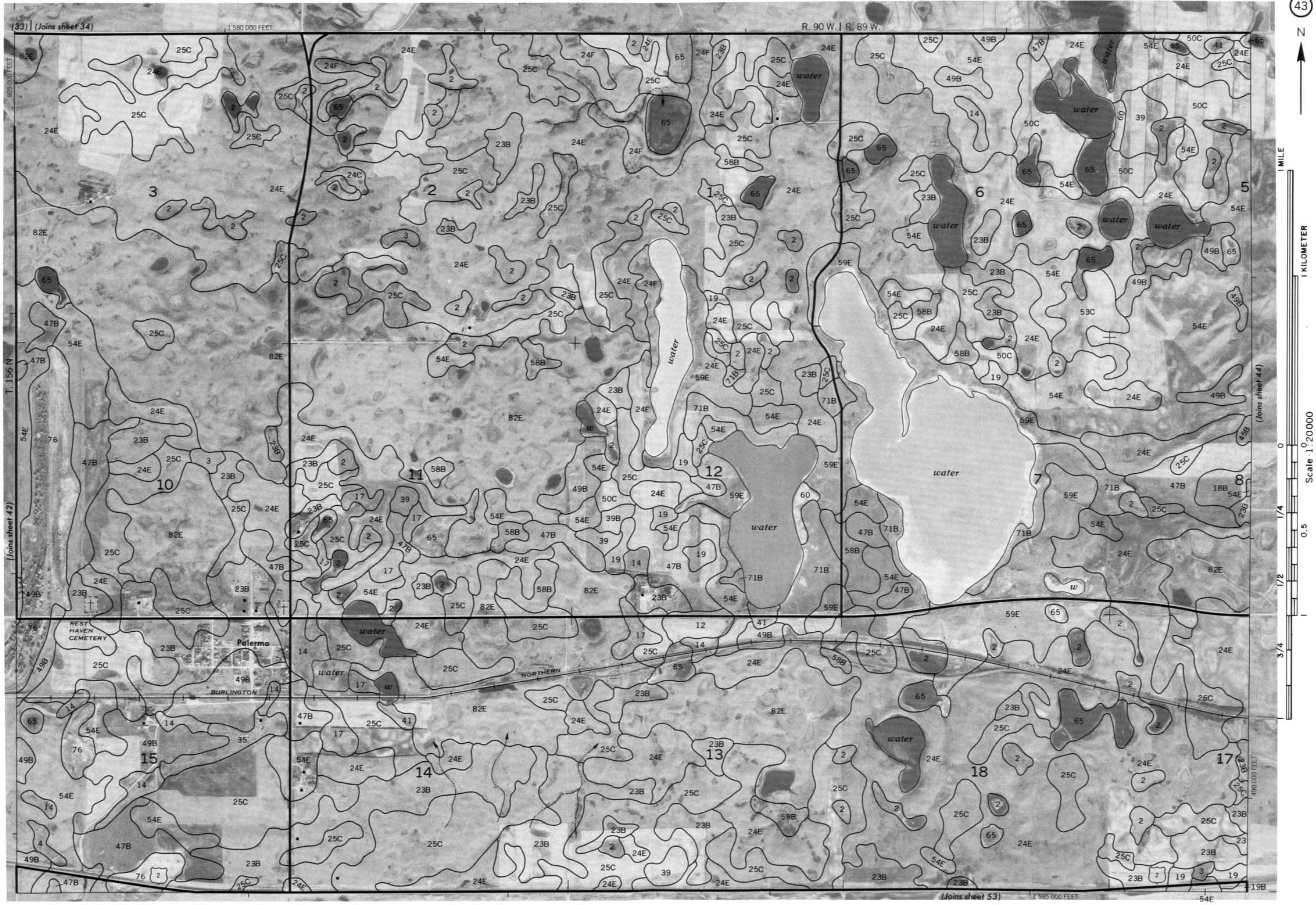


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 41

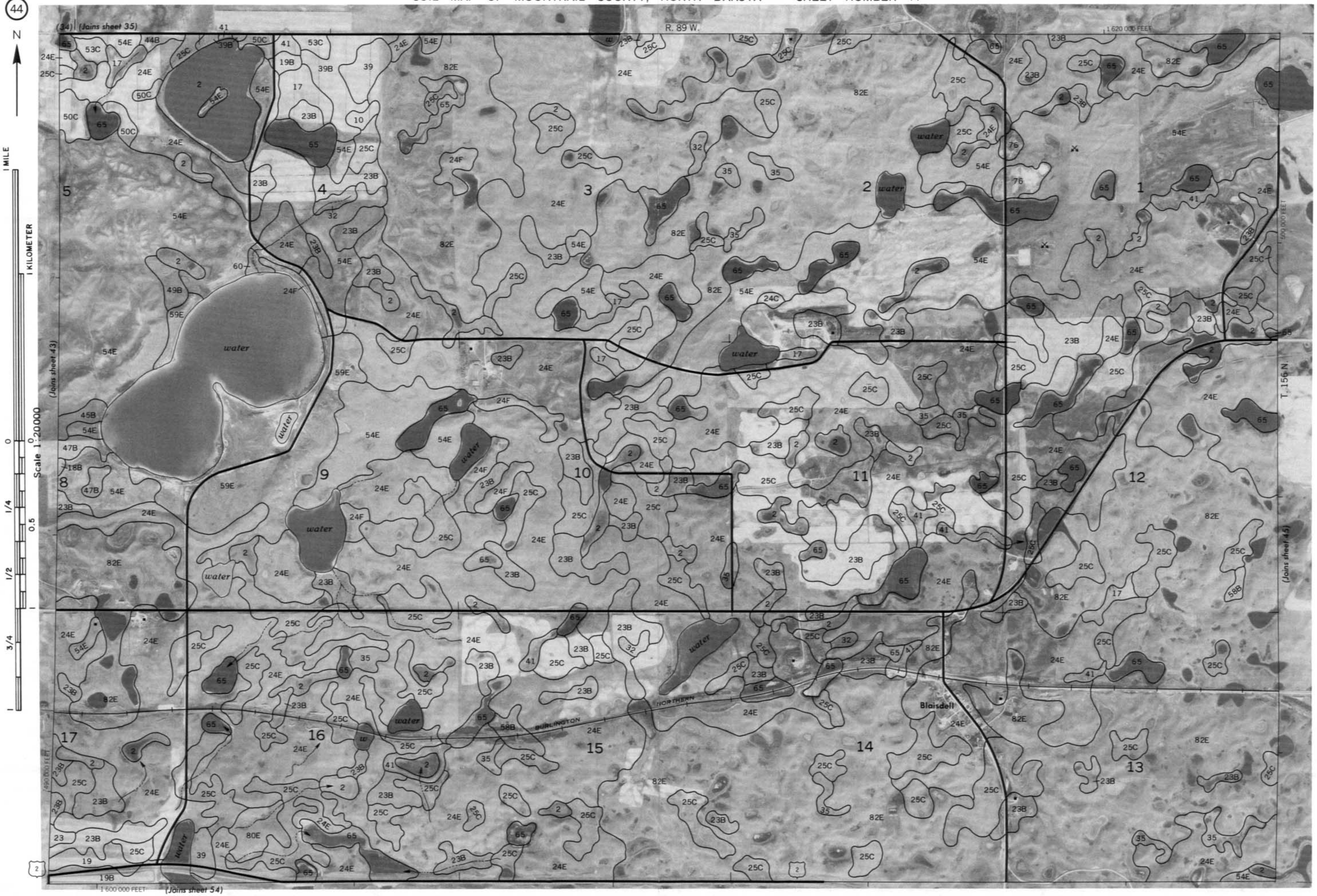



42
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
(Joins sheet 33)
R. 91 W. | R. 90 W.
1 575 000 FEET
505 000 FEET
T. 156 N.
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 52)
1 555 000 FEET
490 000 FEET
BURLINGTON NORTHERN
water
2
1
6
5
4
11
12
7
8
9
14
13
18
17
16

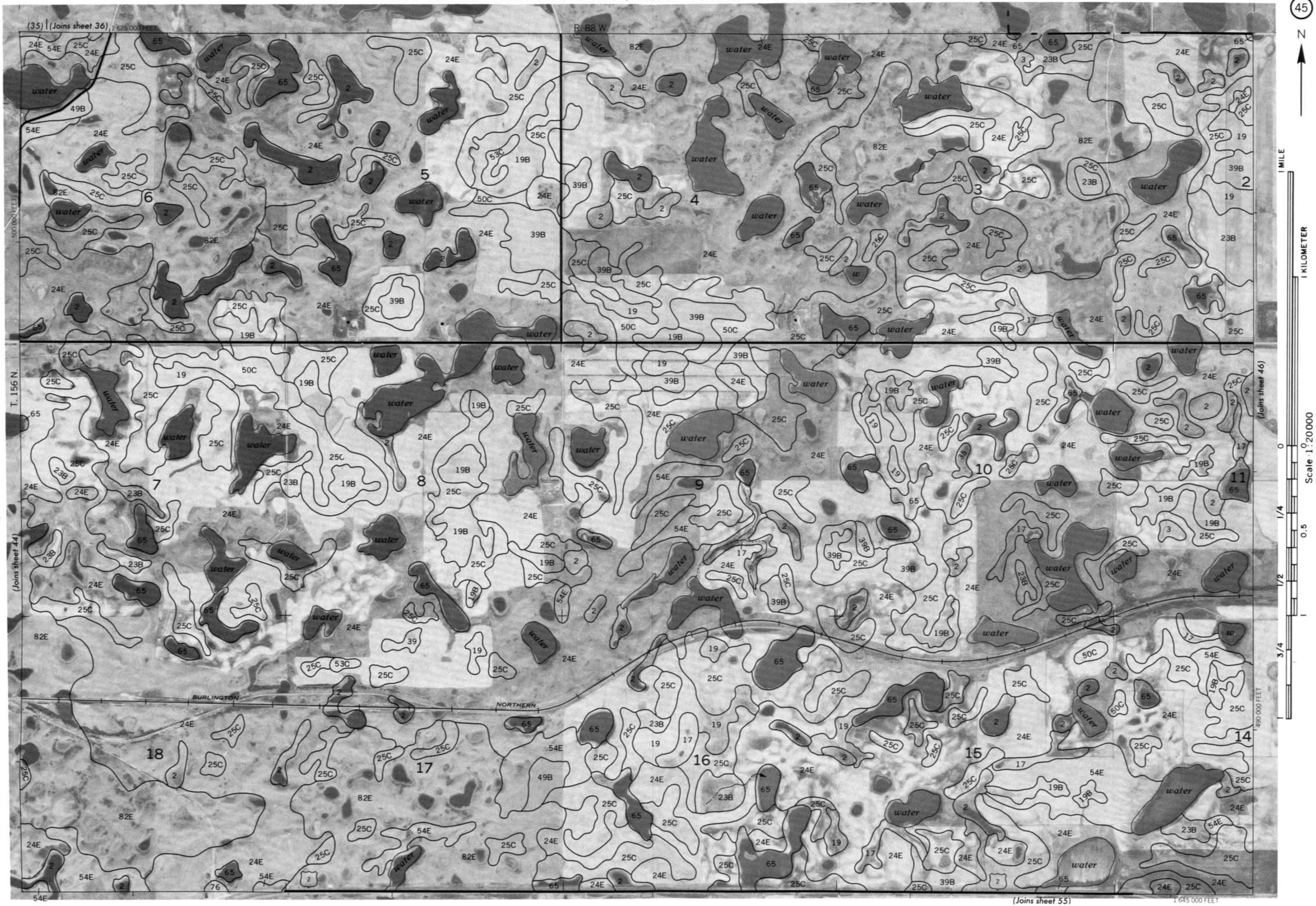
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 43



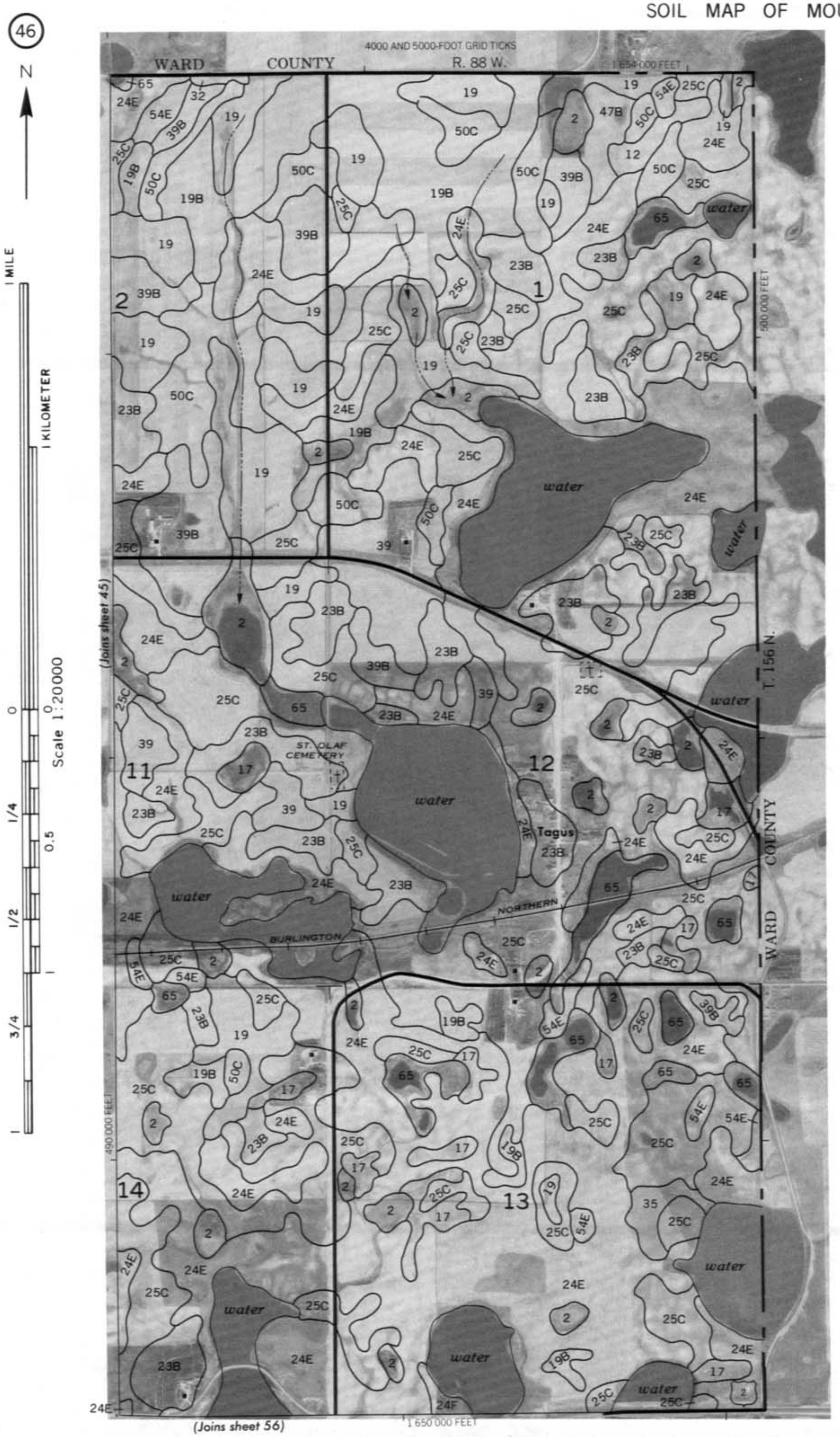
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 44

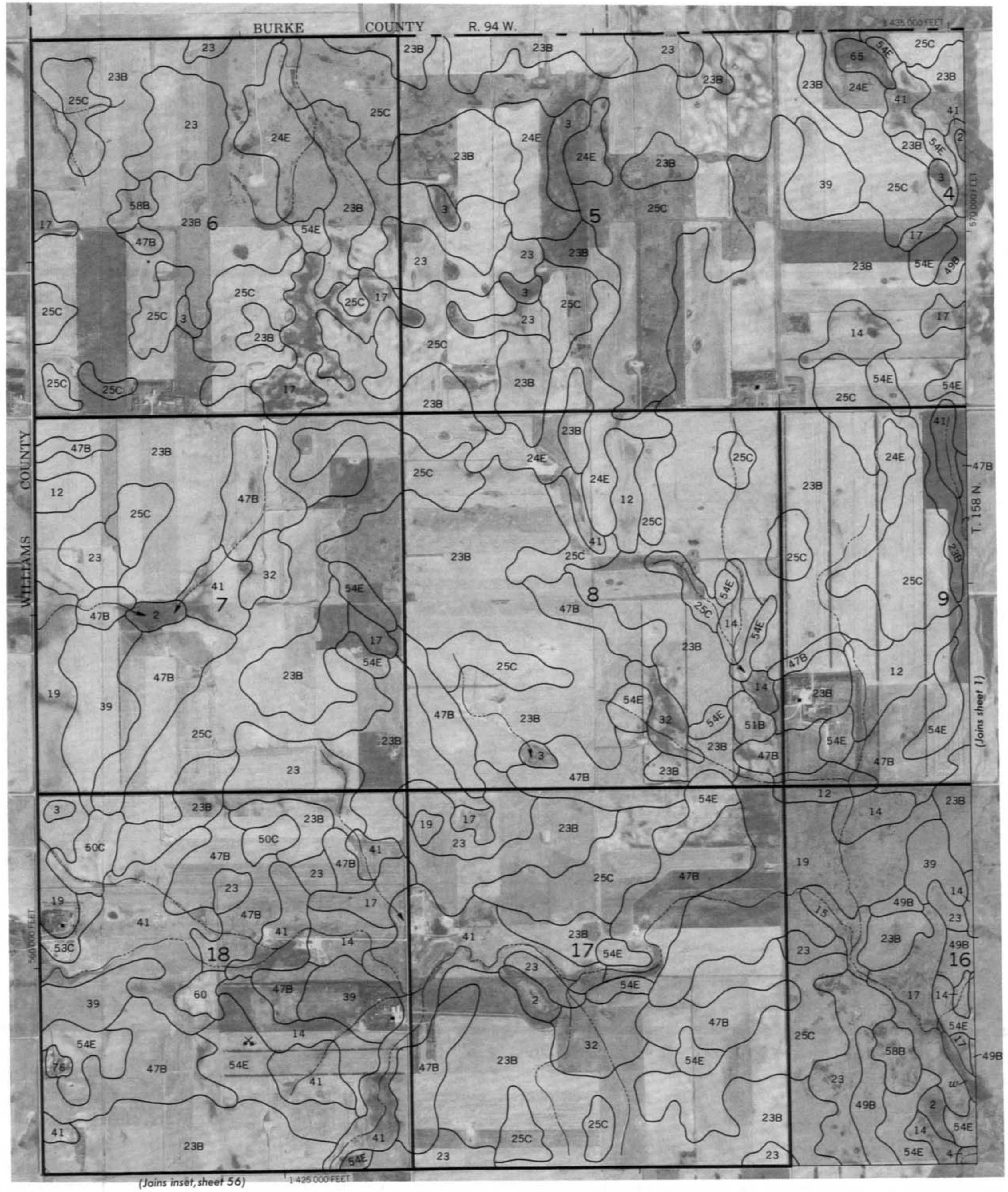


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 45

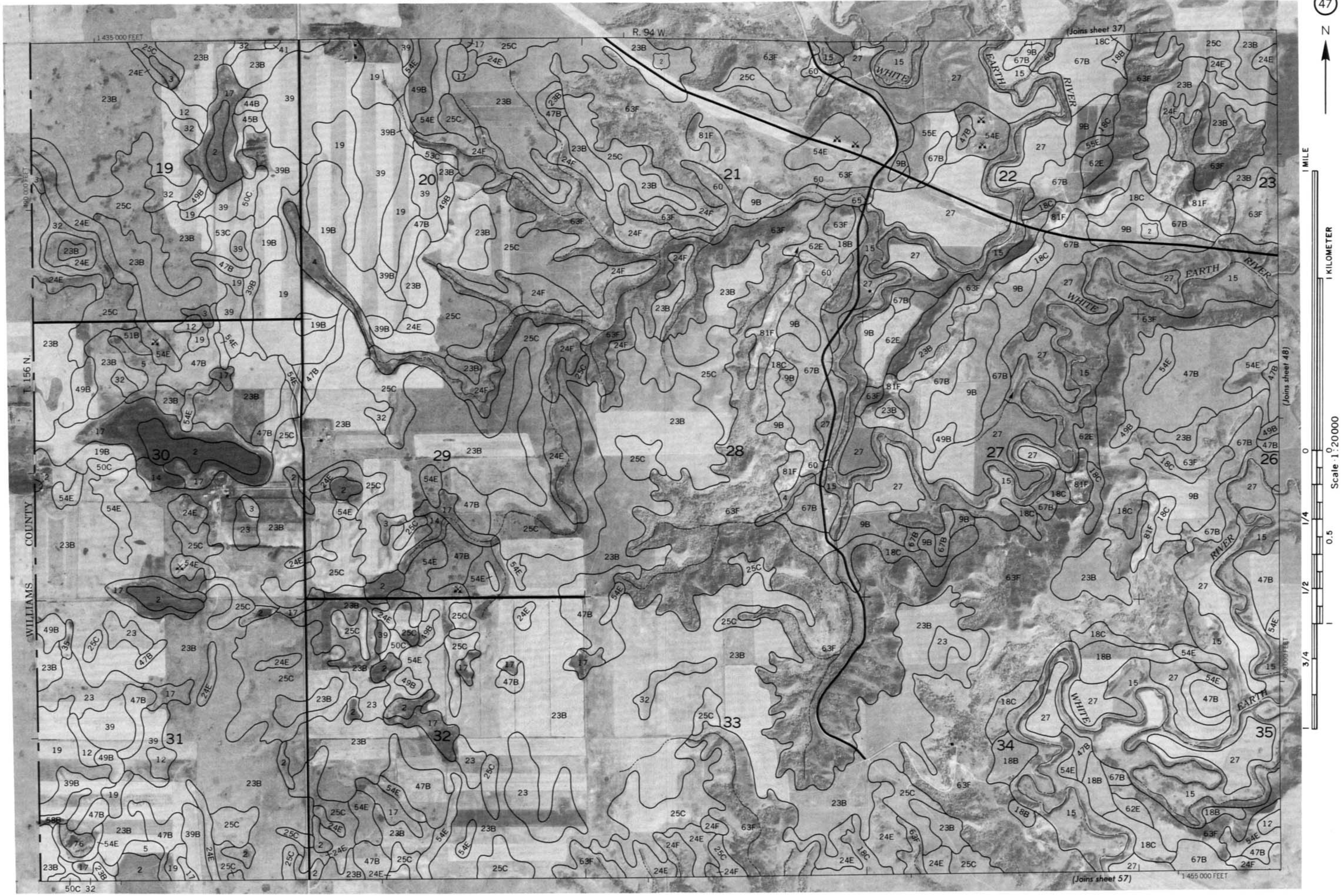


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 46

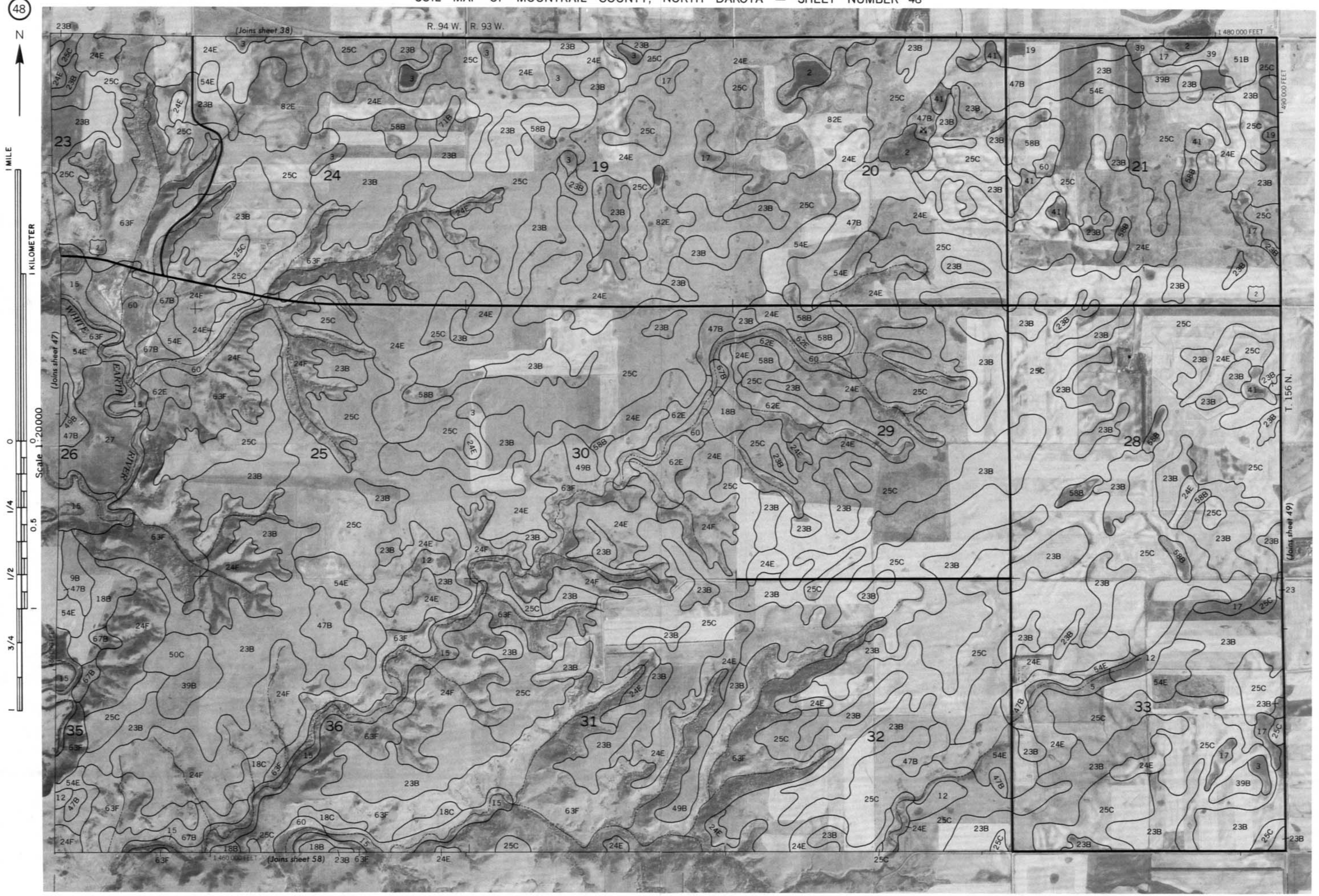


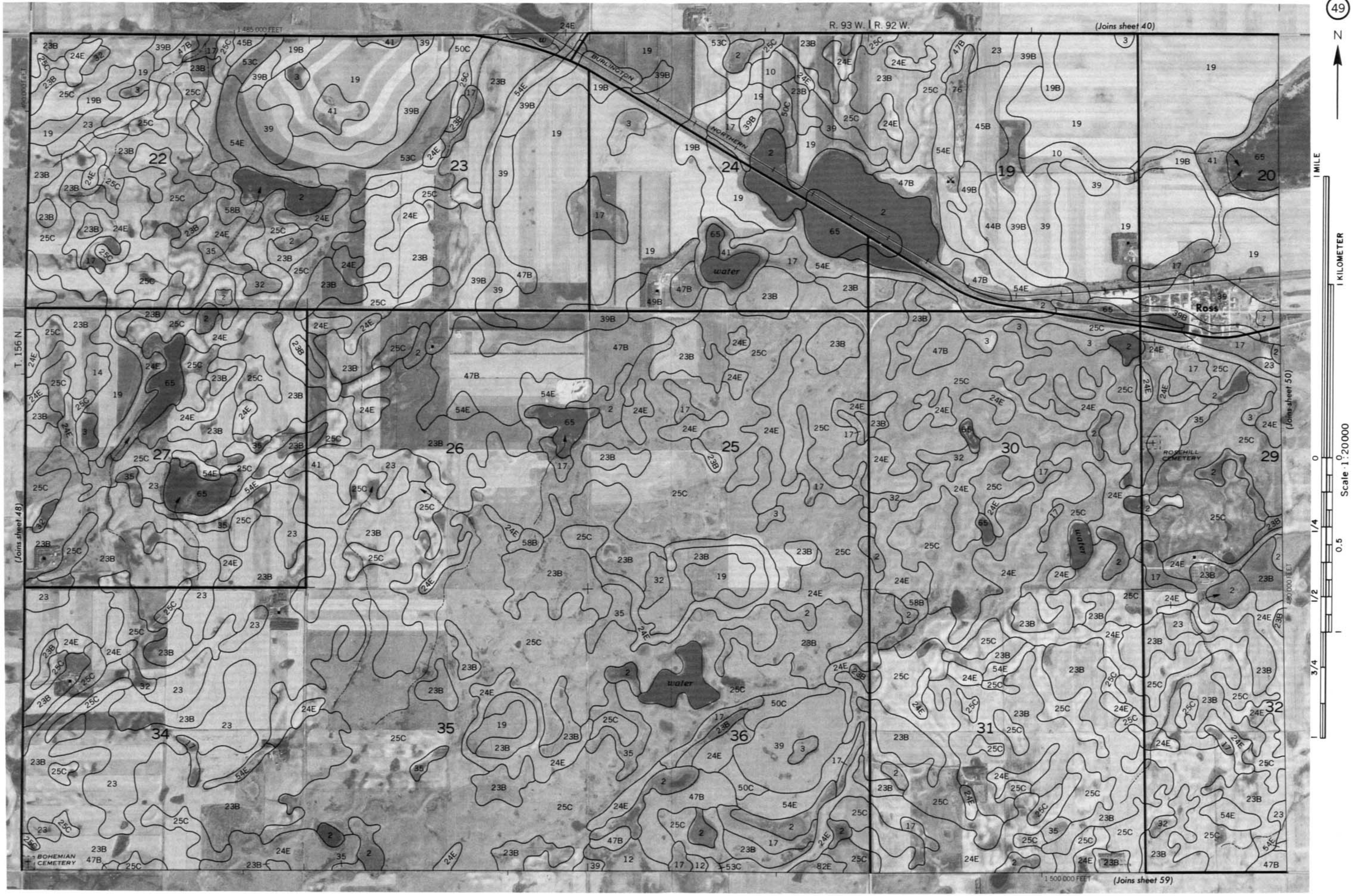


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 47

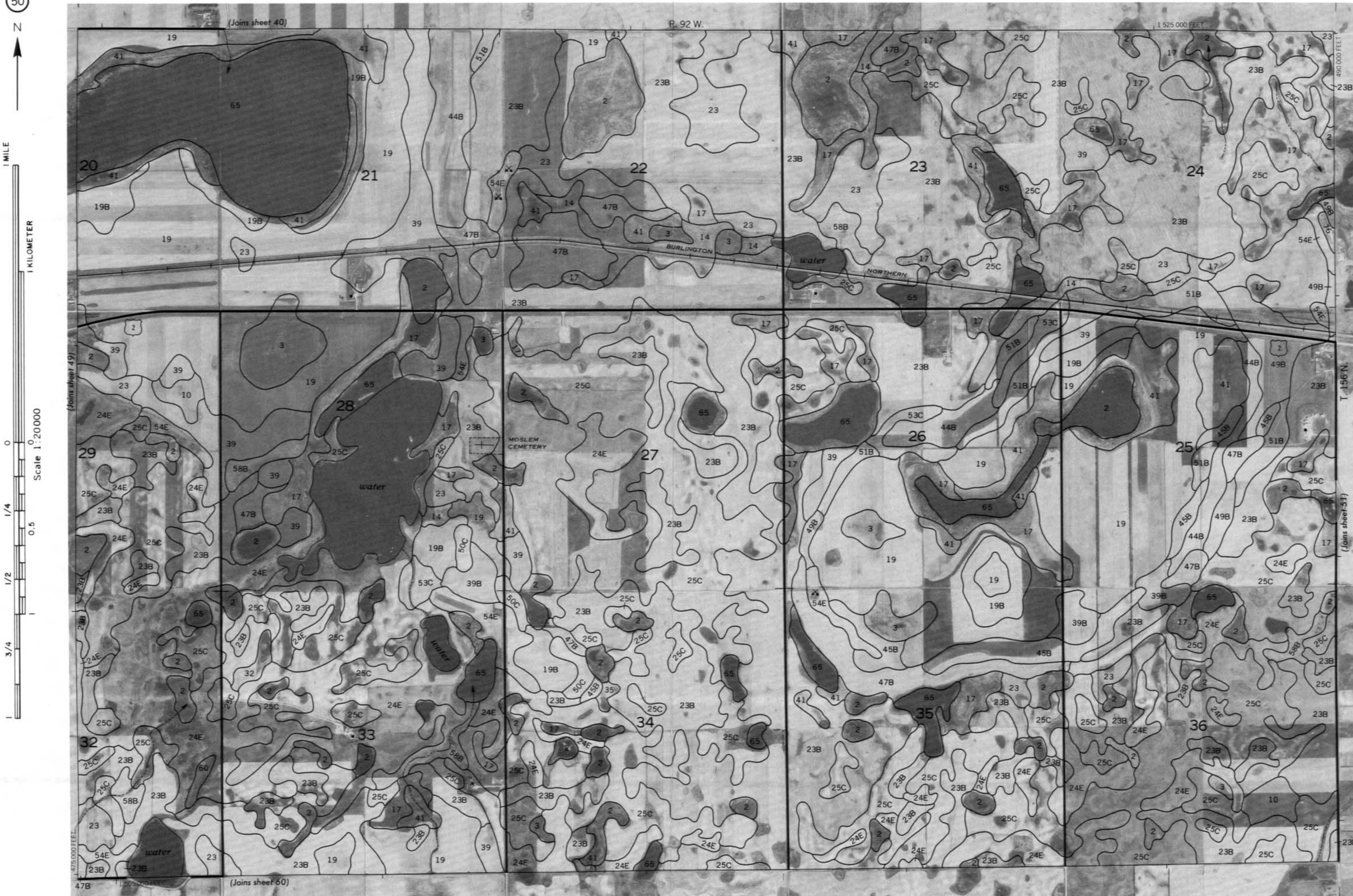


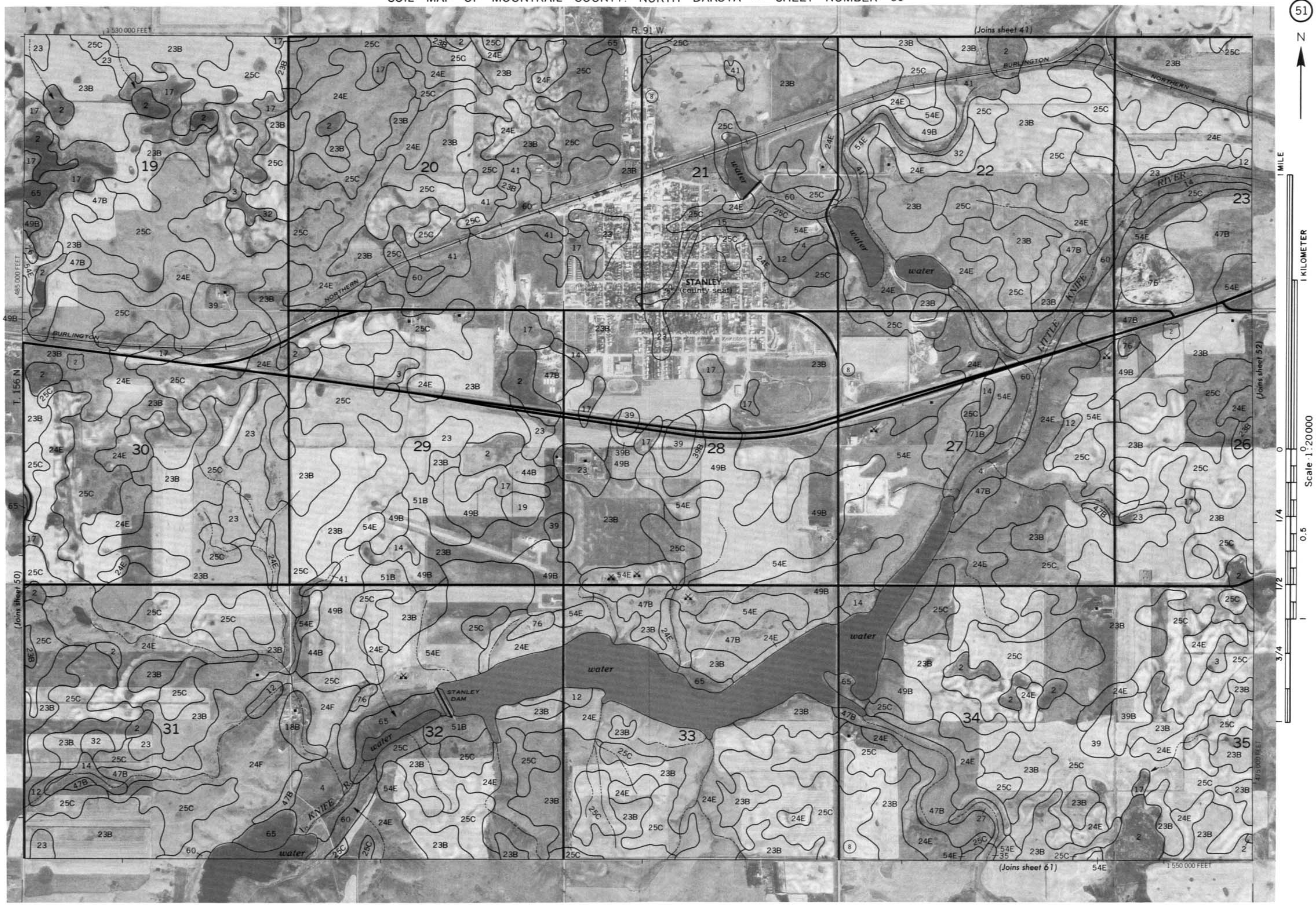
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 48

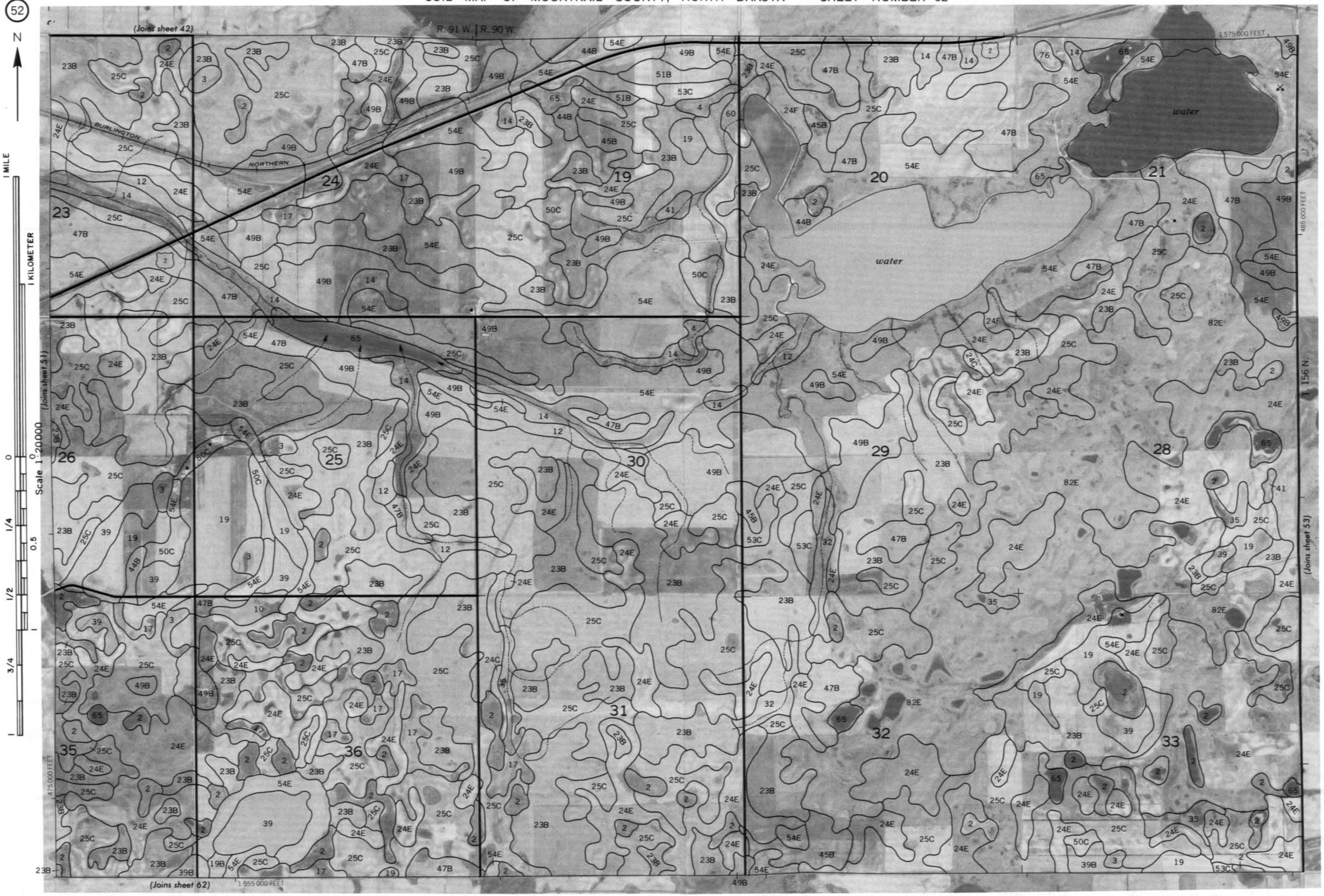



(Joins sheet 40)
R. 93 W. | R. 92 W.
1 485 000 FEET
T. 156 N.
(Joins sheet 48)
(Joins sheet 50)
(Joins sheet 59)
1 500 000 FEET
490 000 FEET
BURLINGTON
NORTHERN
Ross
ROSEHILL CEMETERY
BOHEMIAN CEMETERY
water
N
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

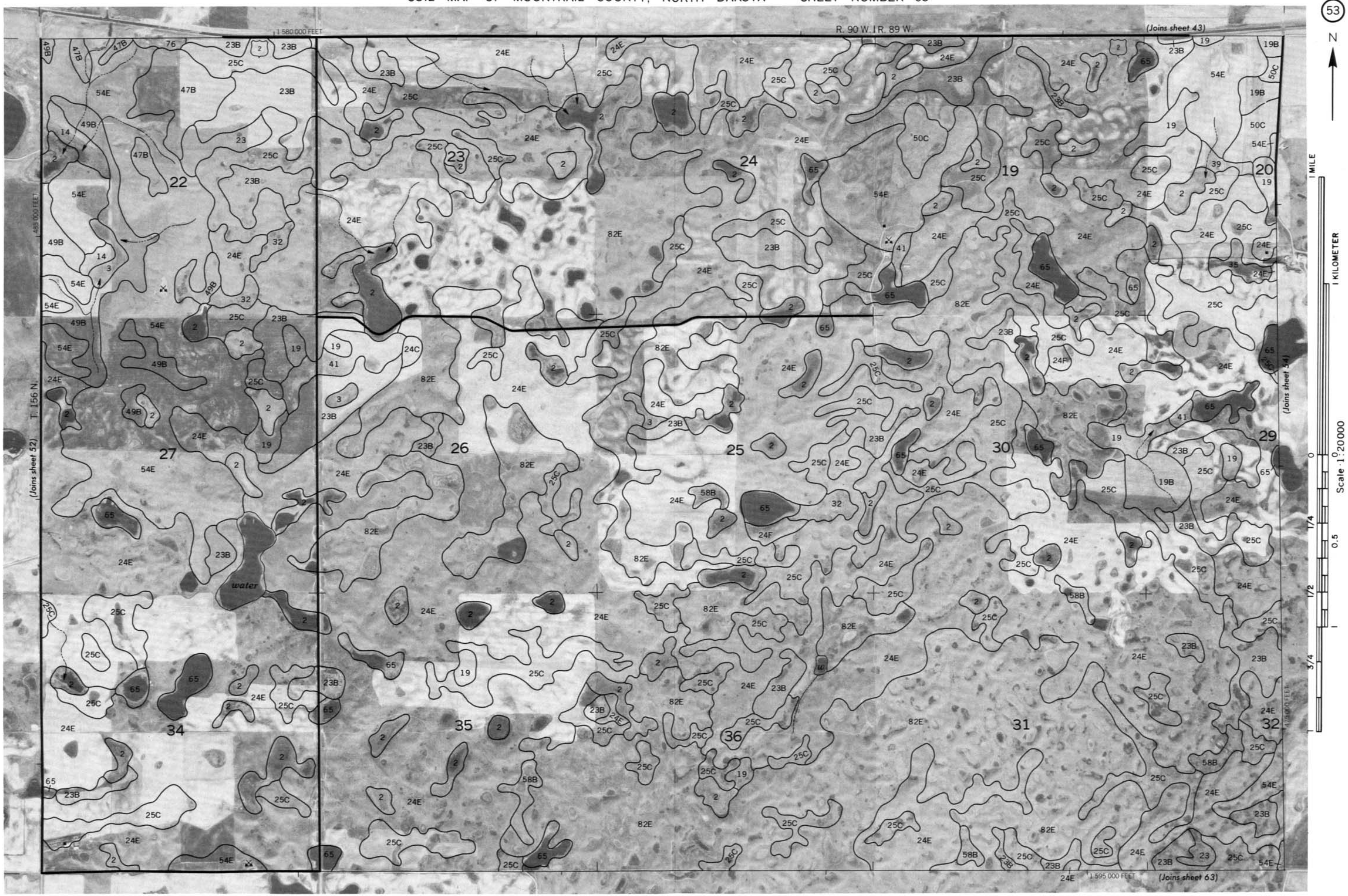
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 50



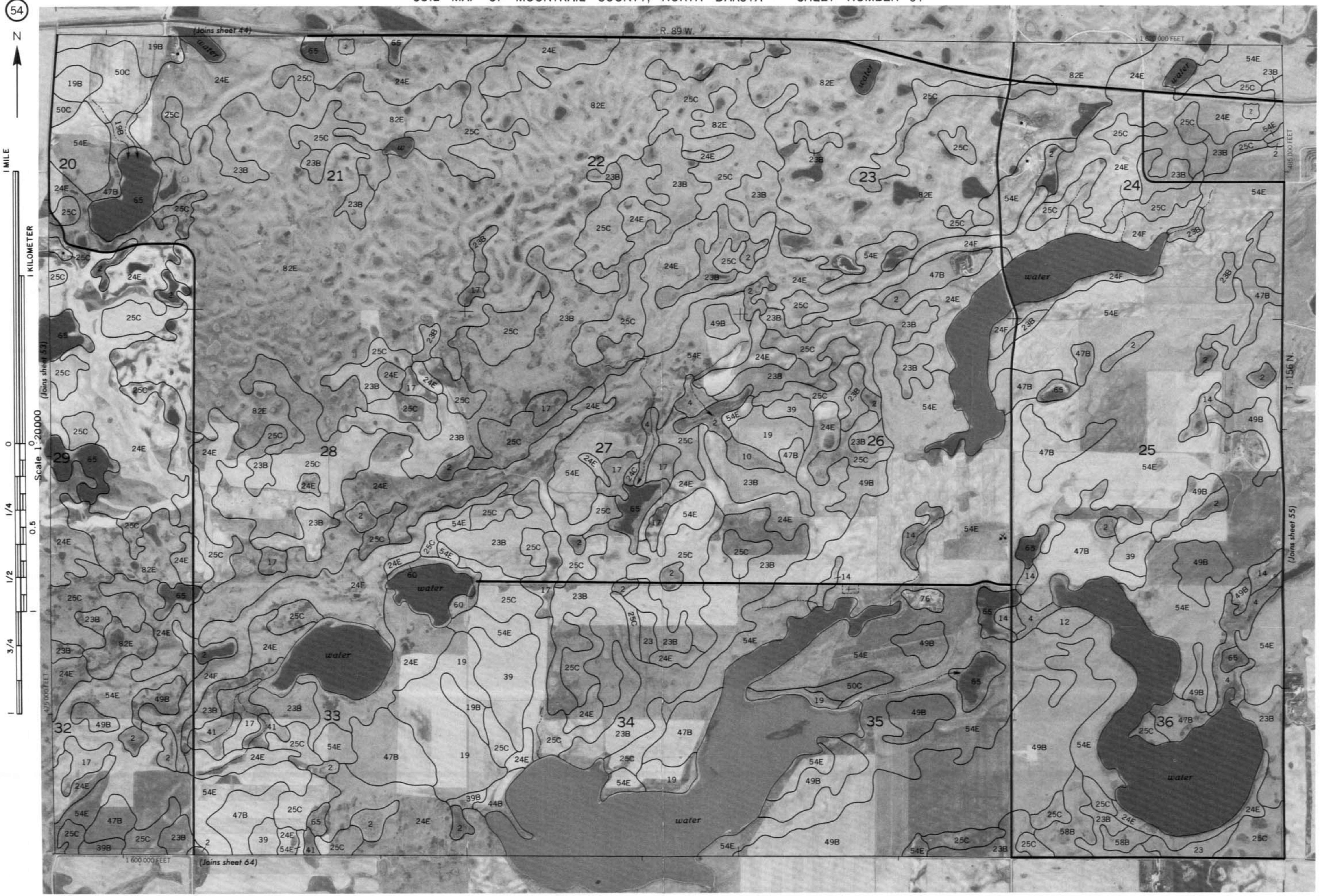

51
N
(Joins sheet 41)
(Joins sheet 52)
(Joins sheet 61)
(Joins sheet 50)
R. 91 W.
T. 156 N.
1 530 000 FEET
1 550 000 FEET
485 000 FEET
475 000 FEET
STANLEY
(county seat)
BURLINGTON
NORTHERN
STANLEY DAM
LITTLE KNIFE RIVER
L. KNIFE R.
water
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

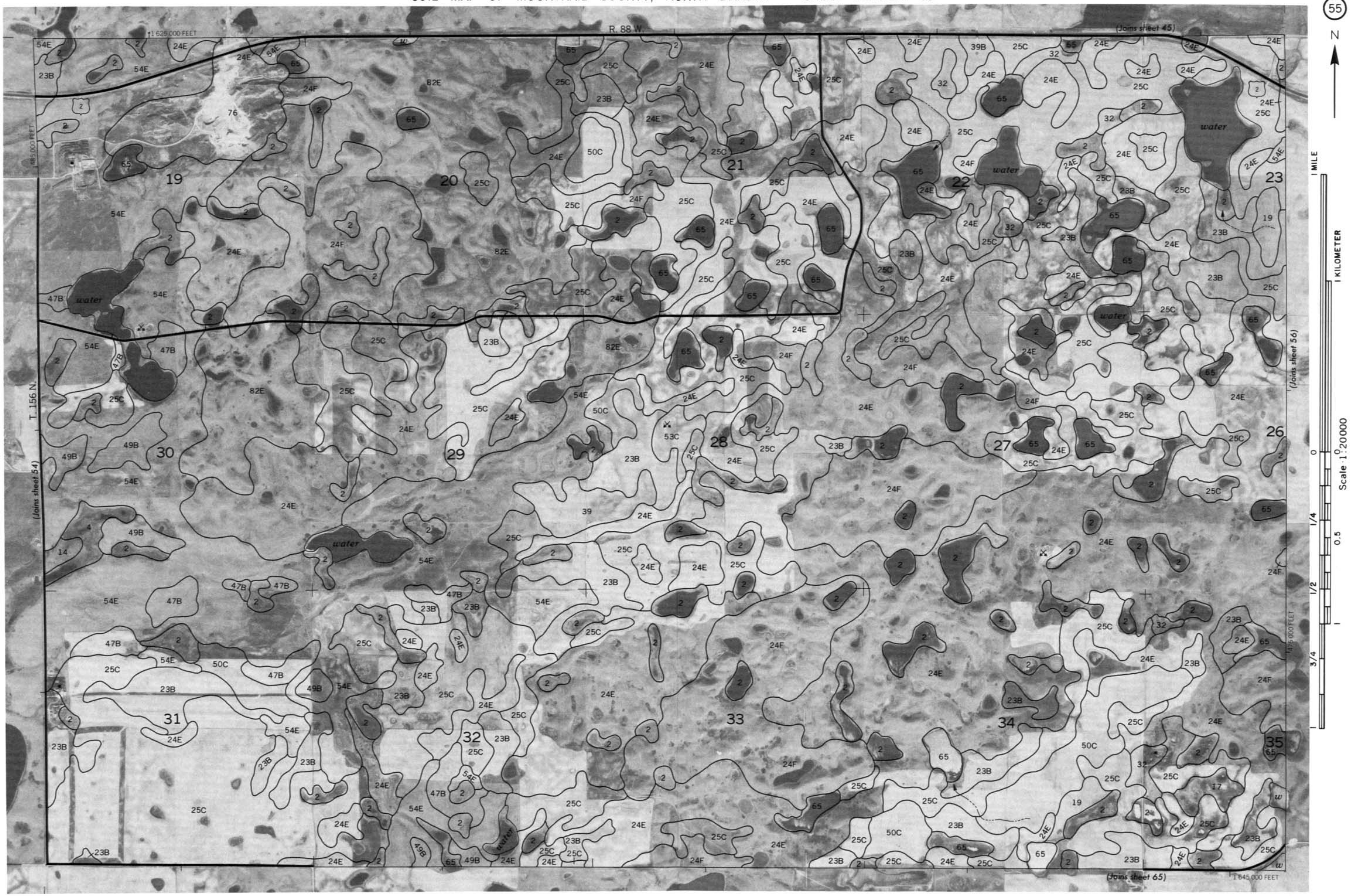

52
N
(Joins sheet 42)
R. 91 W. | R. 90 W.
1 575 000 FEET
BURLINGTON
NORTHERN
water
water
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 62)
1 555 000 FEET
475 000 FEET
485 000 FEET
T. 156 N.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

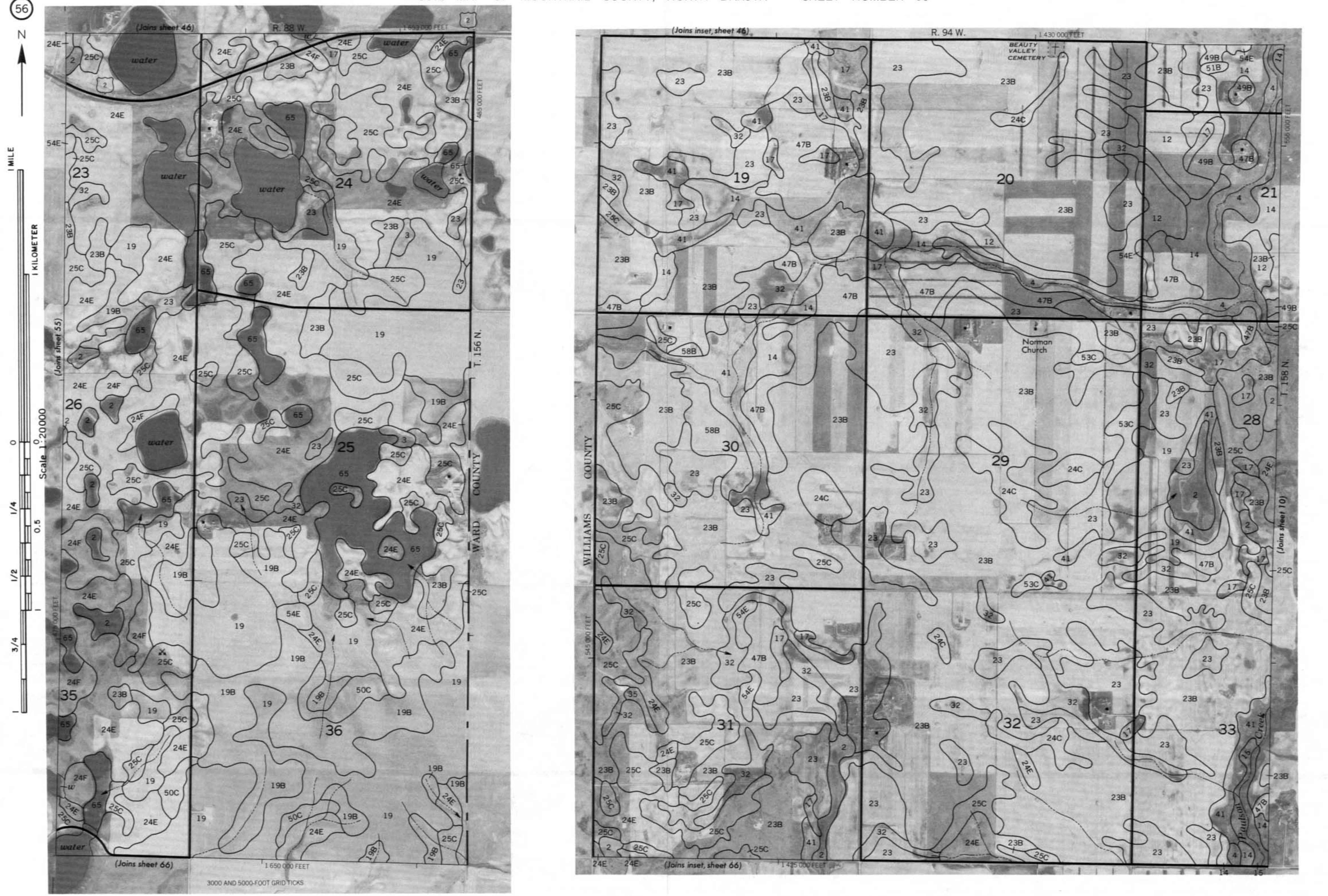
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 53

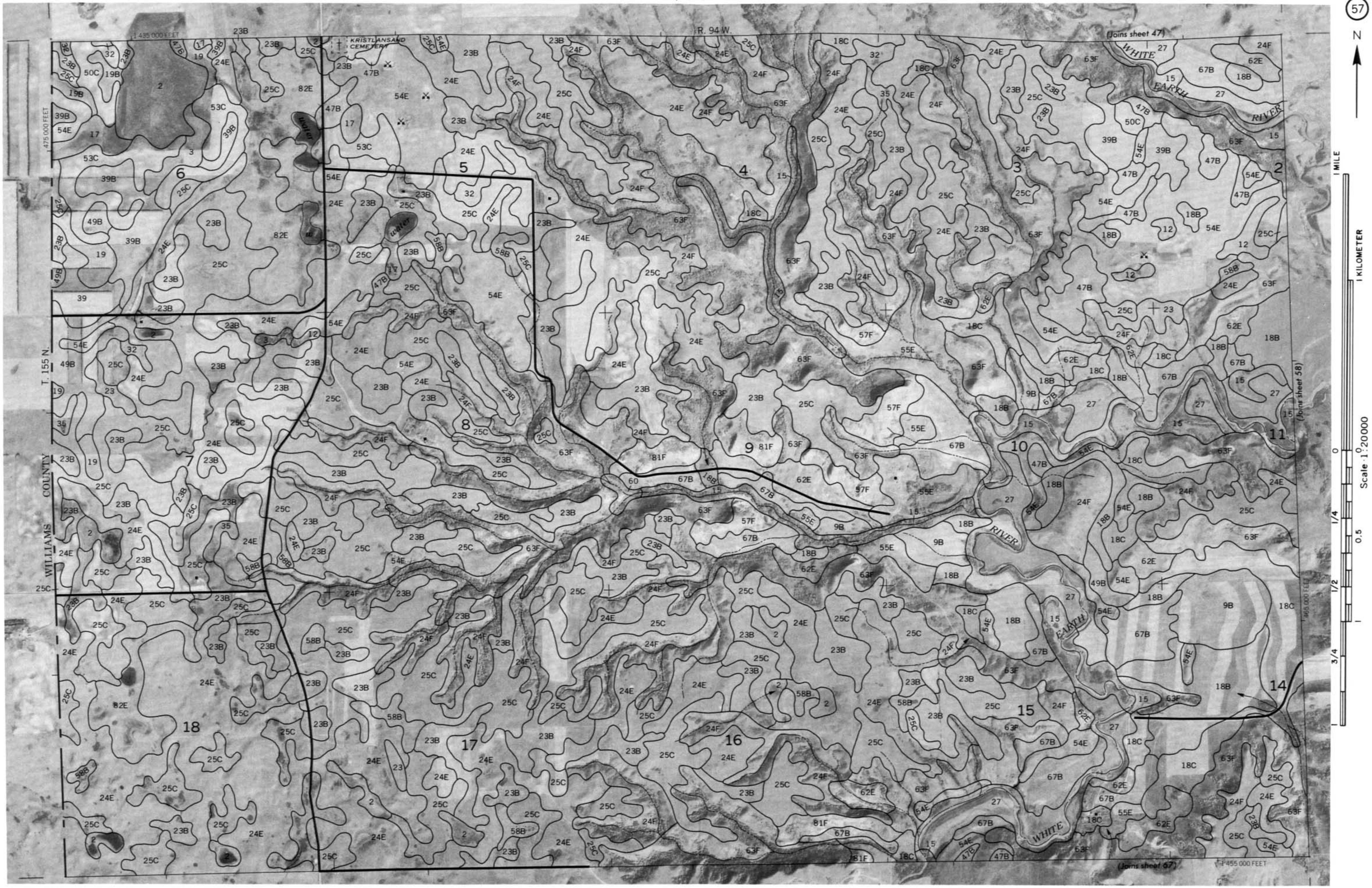


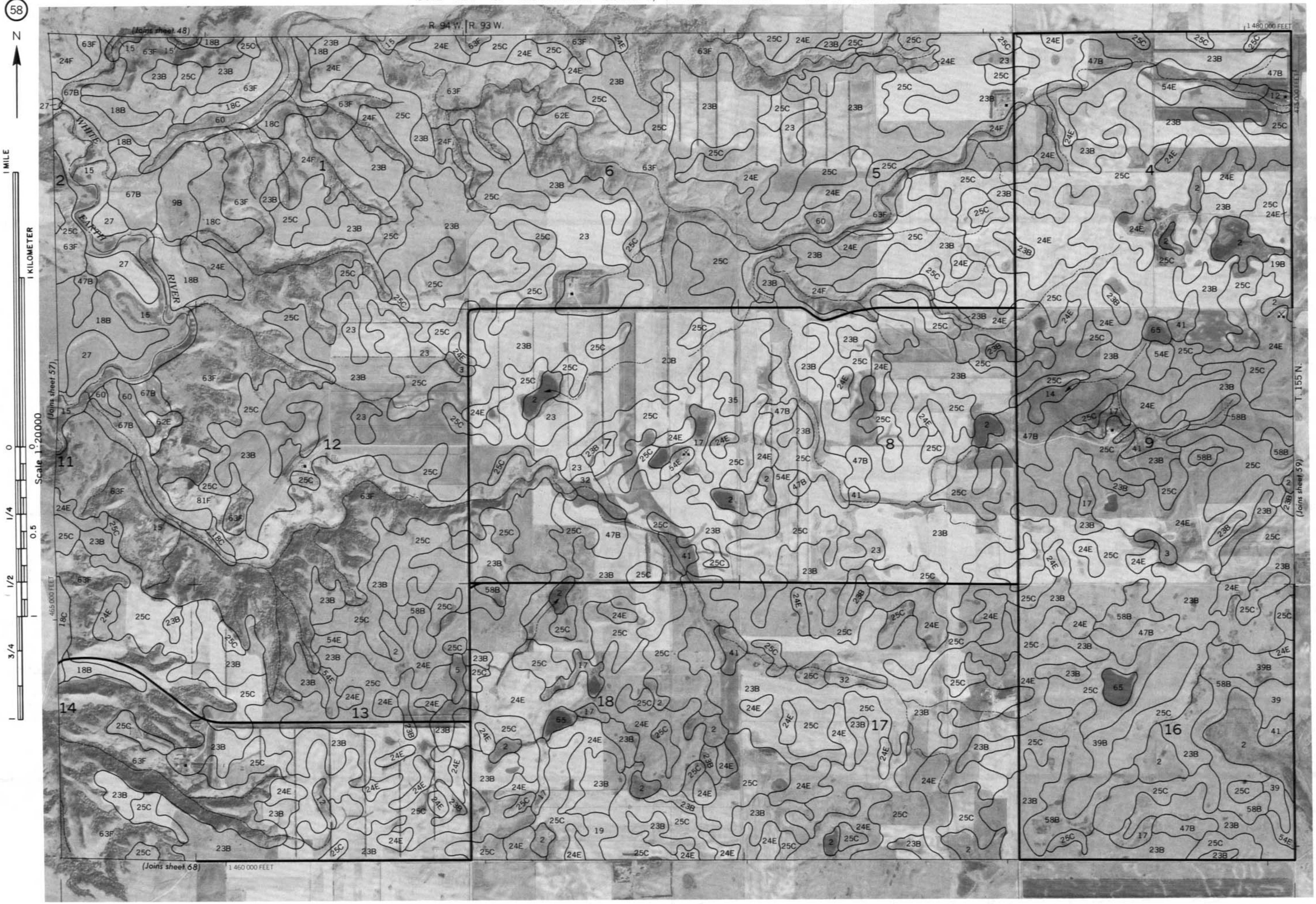
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 54



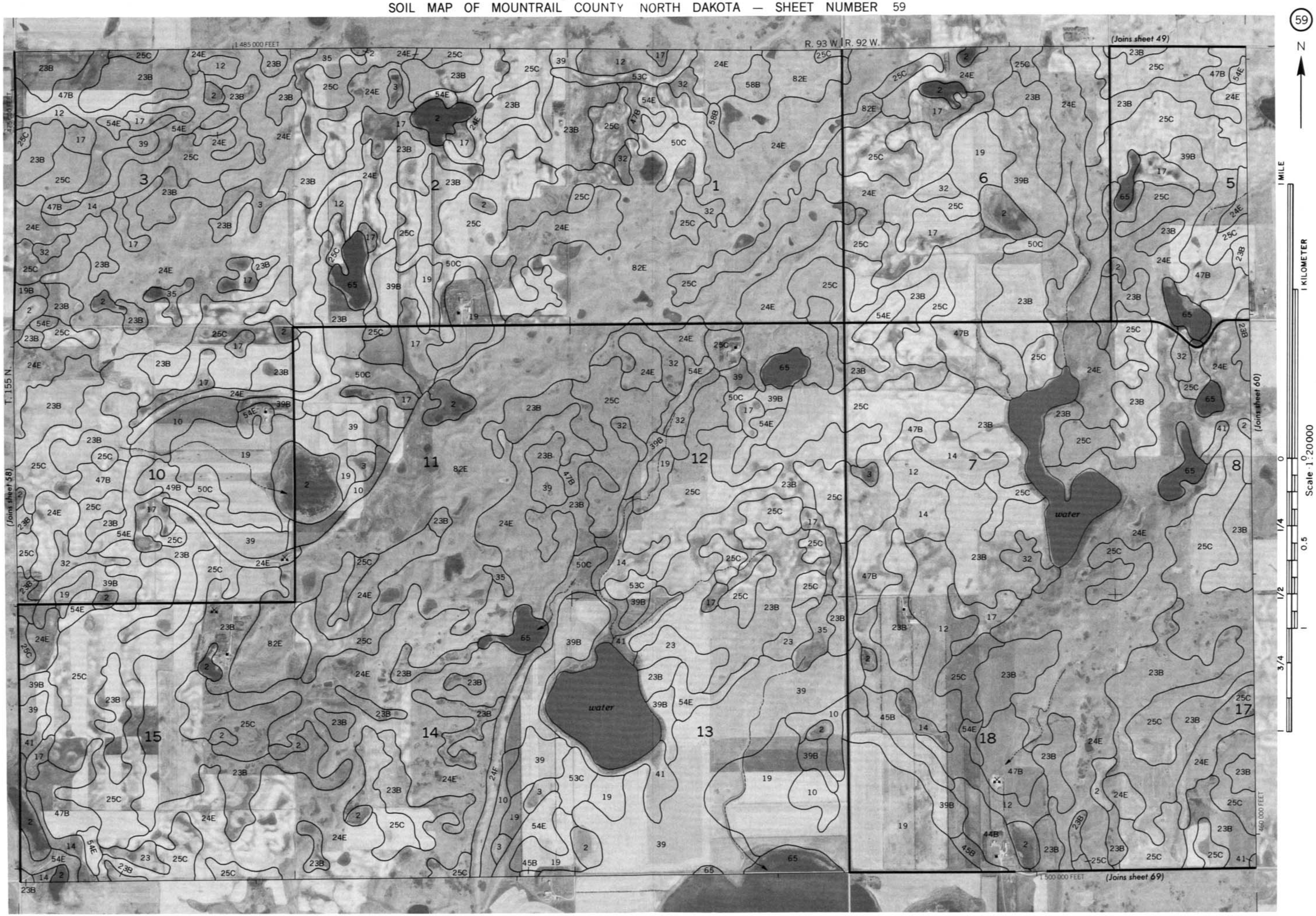

55
N
R. 88 W.
(Joins sheet 45)
1 625 000 FEET
485 000 FEET
T. 156 N.
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 65)
1 645 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


56
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 46)
R. 88 W.
(Joins sheet 55)
T. 156 N.
WARD COUNTY
(Joins sheet 66)
3000 AND 5000-FOOT GRID TICKS
(Joins inset, sheet 46)
R. 94 W.
BEAUTY VALLEY CEMETERY
Norman Church
WILLIAMS COUNTY
T. 158 N.
(Joins sheet 10)
(Joins inset, sheet 66)
Paulson Creek

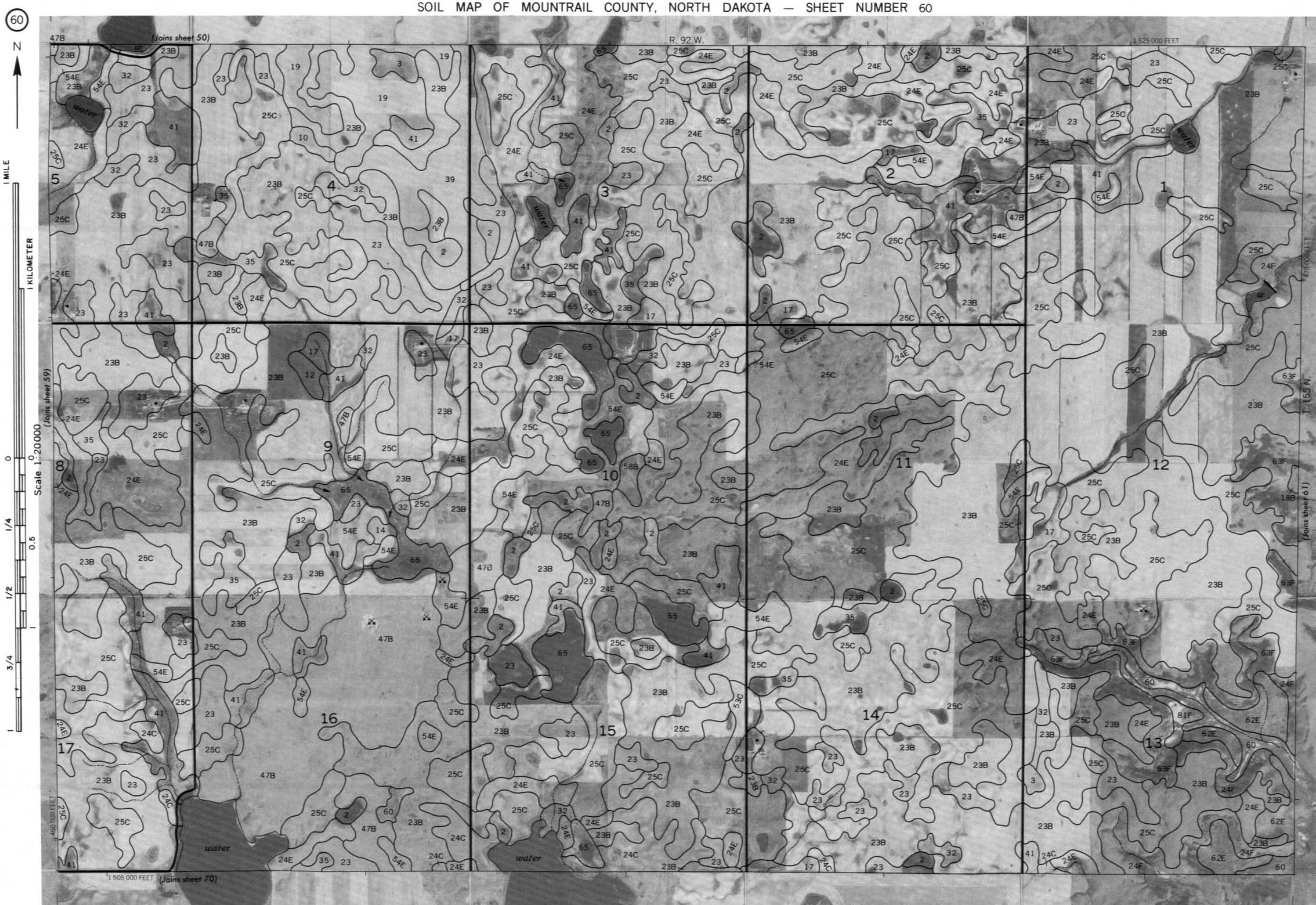

R. 94 W.
T. 155 N.
WILLIAMS COUNTY
KRISTIANSAND CEMETERY
(Joins sheet 47)
(Joins sheet 58)
(Joins sheet 67)
WHITE EARTH RIVER
1 435 000 FEET
475 000 FEET
465 000 FEET
1 455 000 FEET
water
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5


58
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 48)
R. 94 W.
R. 93 W.
1 480 000 FEET
WHITE
EARTH
RIVER
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 68)
1 460 000 FEET
465 000 FEET
425 000 FEET
T. 155 N.

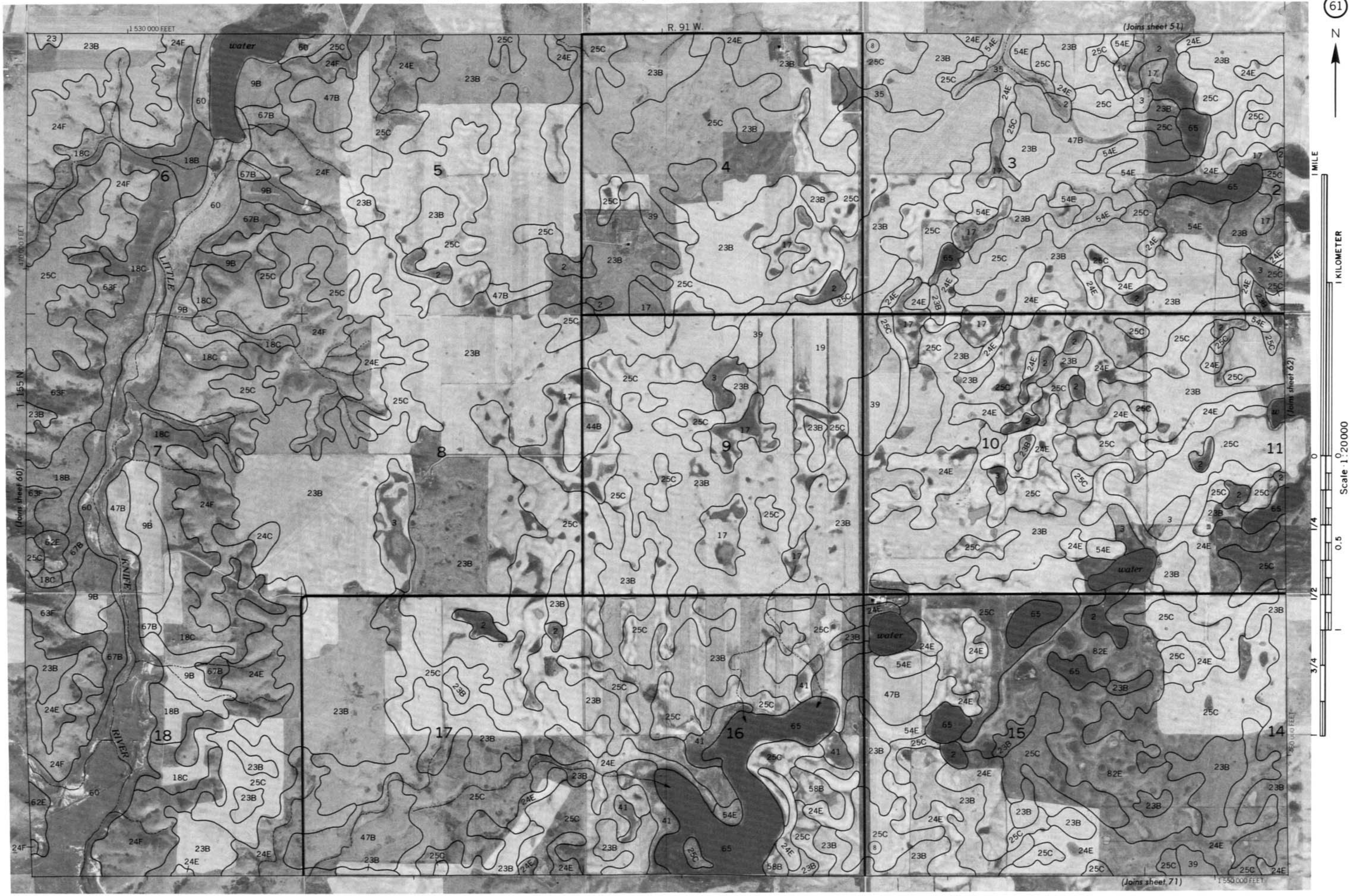
SOIL MAP OF MOUNTRAIL COUNTY NORTH DAKOTA — SHEET NUMBER 59

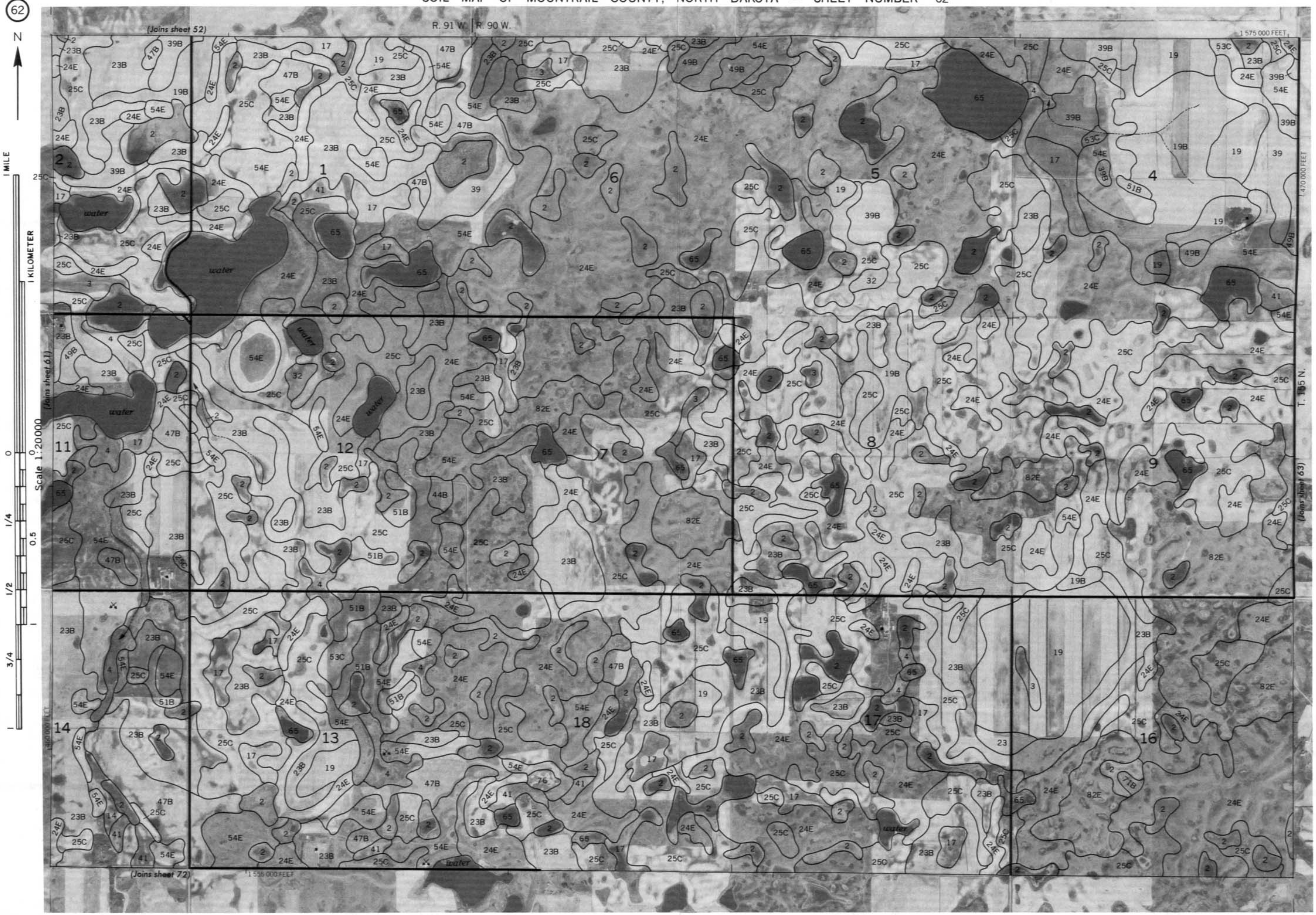


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 60



SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 61

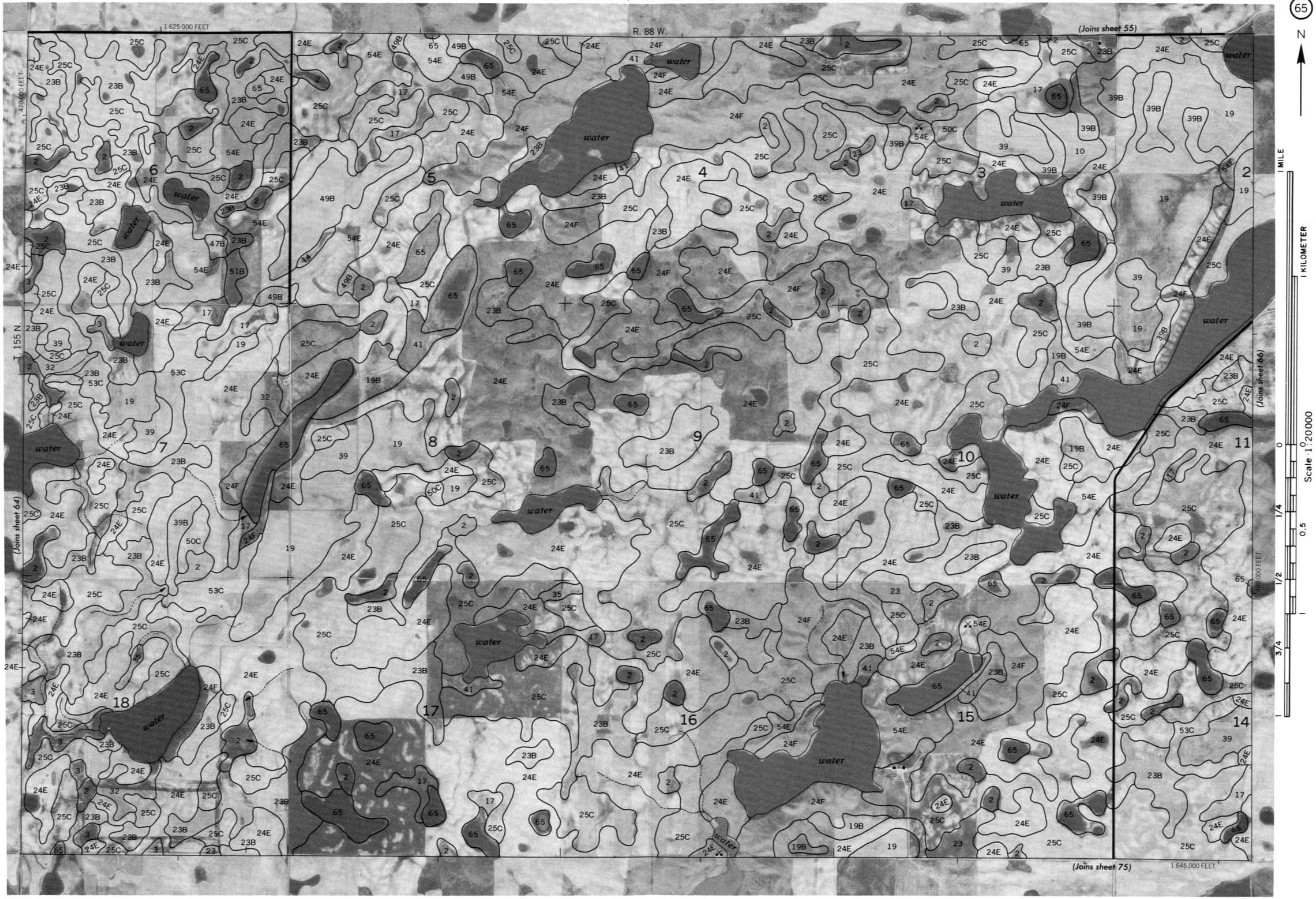



62
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 52)
R. 91 W.
R. 90 W.
1 575 000 FEET
1 470 000 FEET
T. 155 N.
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 72)
1 555 000 FEET
1
4
5
6
7
8
9
11
12
13
14
16
17
18
water

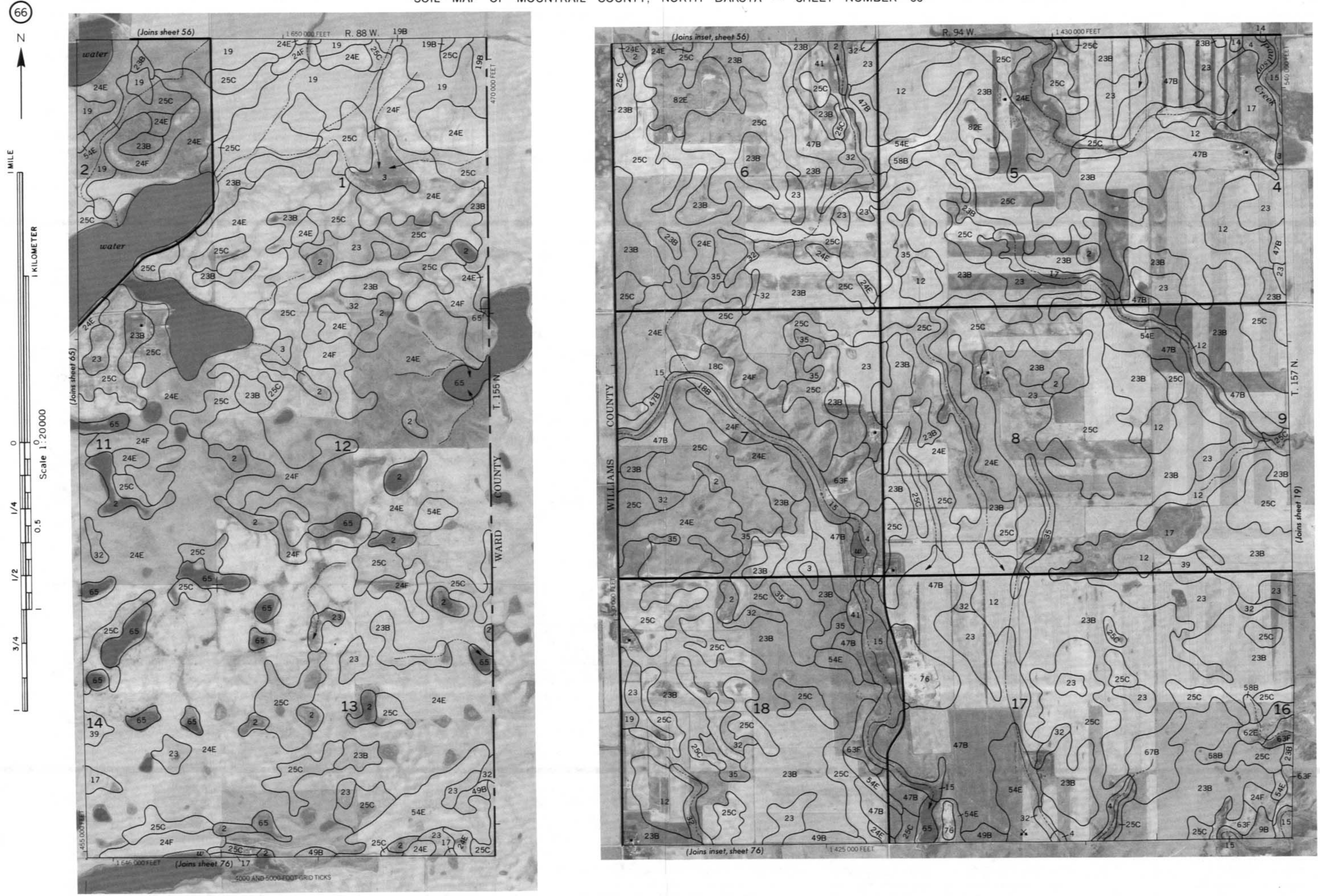

63
N
R. 90 W. | R. 89 W.
(Joins sheet 53)
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 73)
T. 155 N.
1 585 000 FEET
1 595 000 FEET
470 000 FEET
460 000 FEET
water
McAlmond
Lake
1 MILE
1 KILOMETER
Scale 1:20000

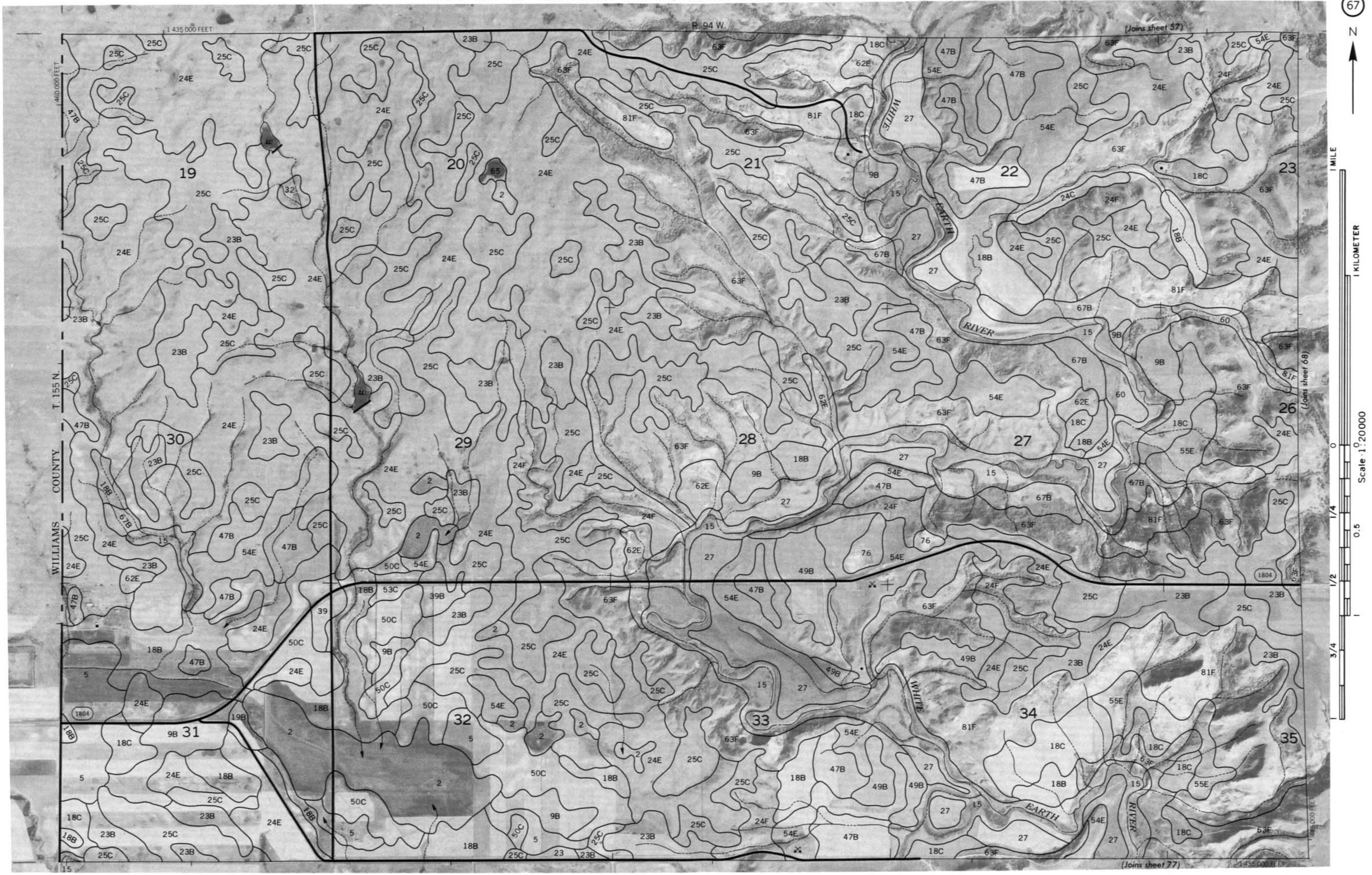
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 64

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 65

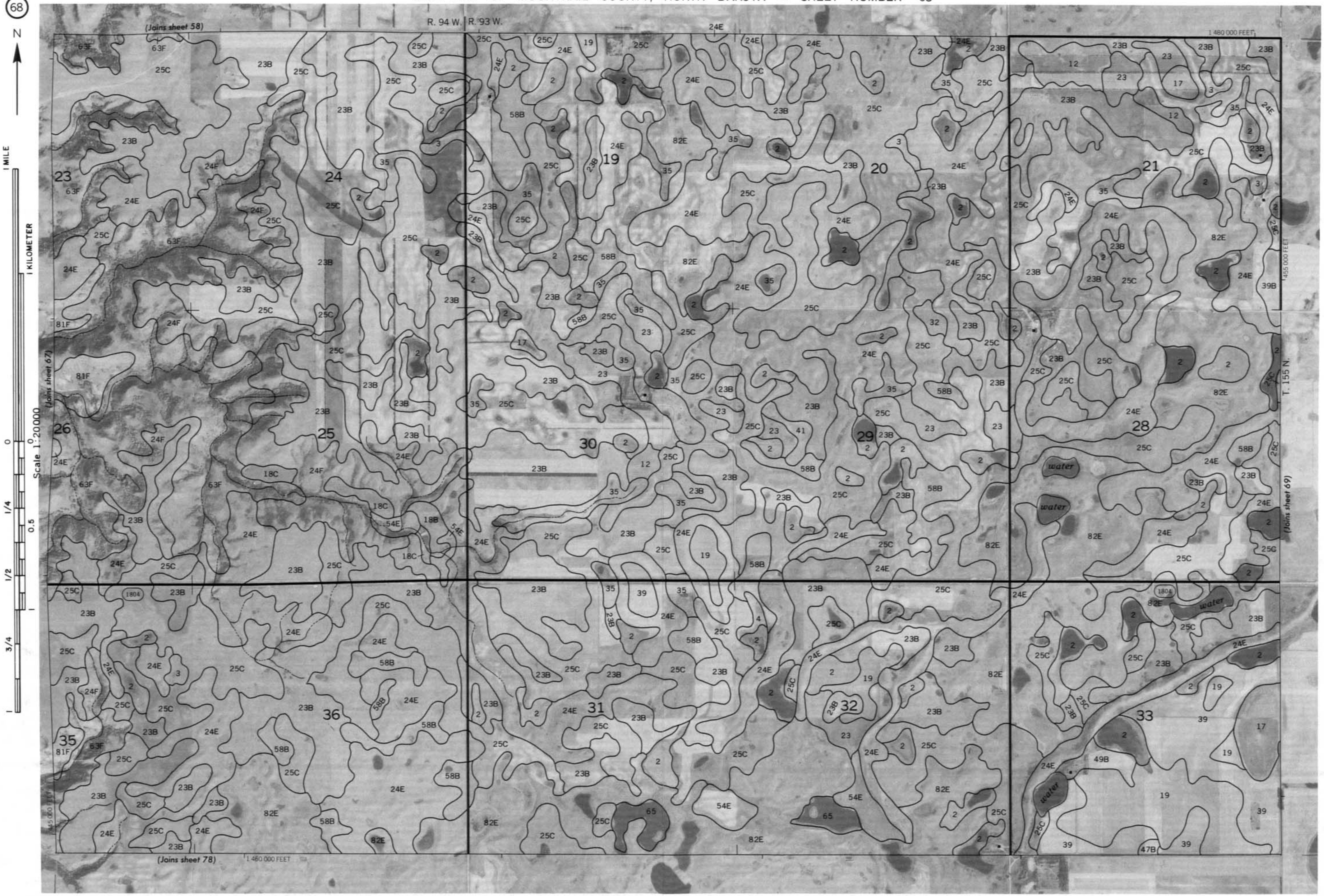


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 66

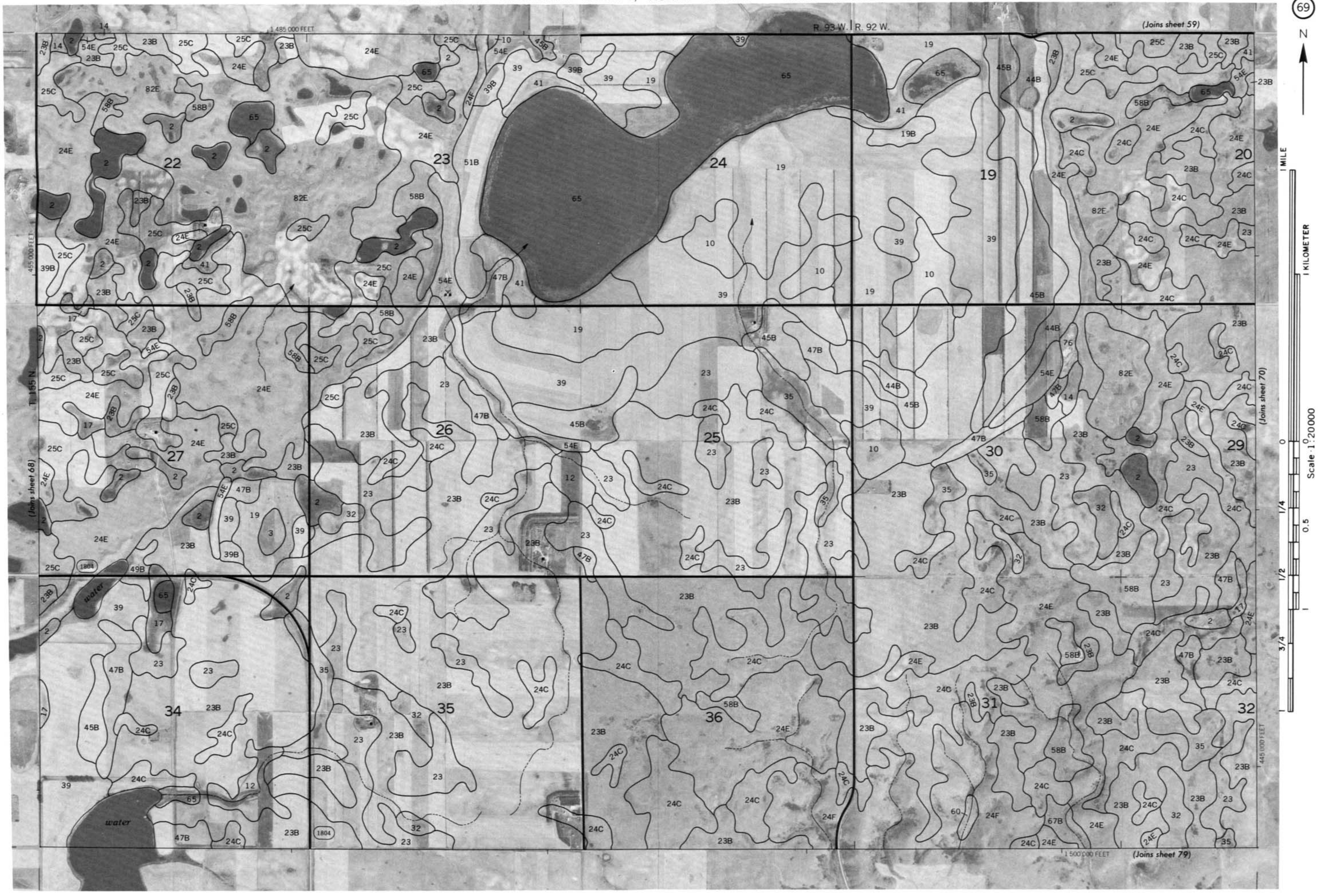


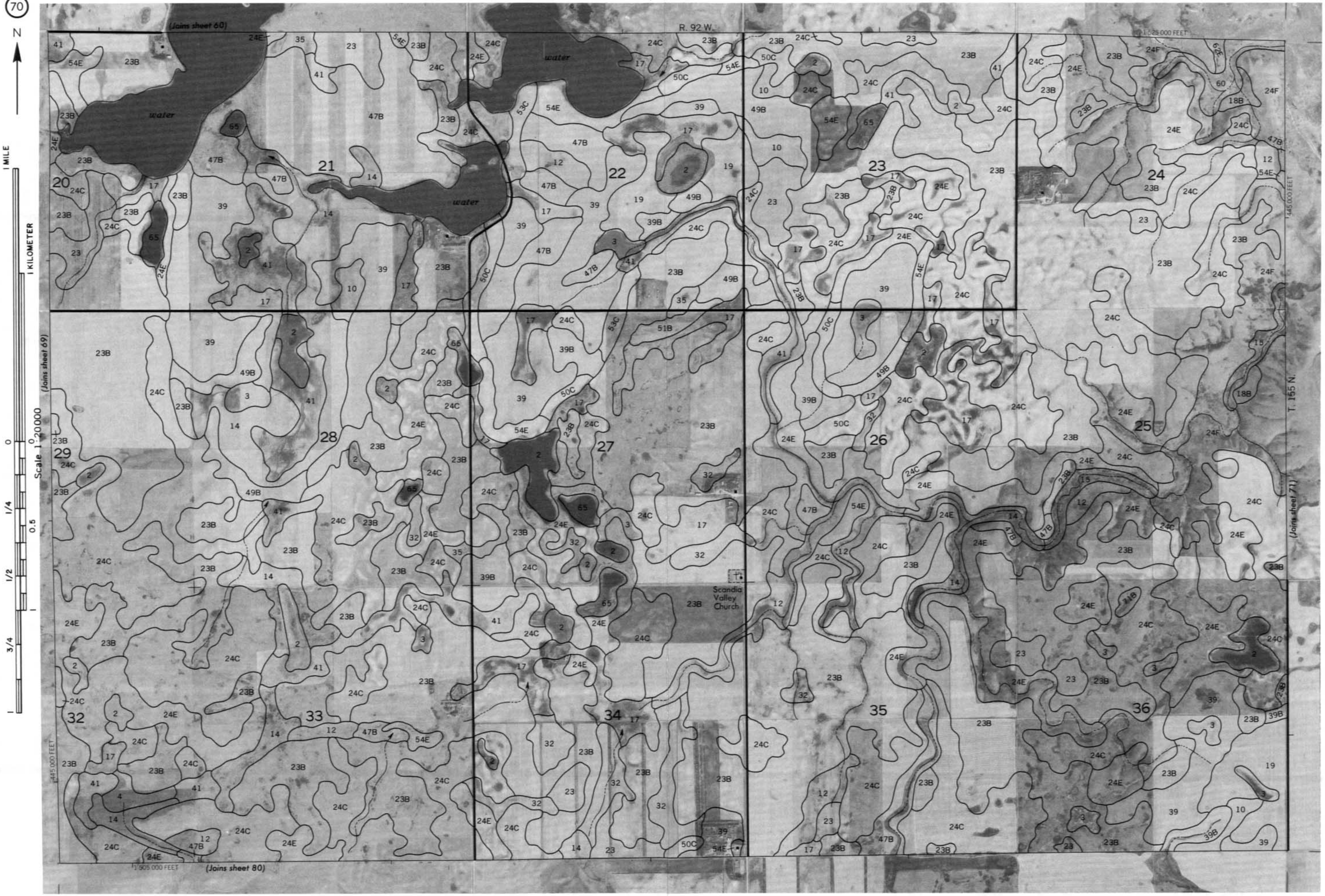

R. 94 W.
(Joins sheet 57)
(Joins sheet 68)
(Joins sheet 77)
1 435 000 FEET
460 000 FEET
1 455 000 FEET
456 000 FEET
T. 155 N.
WILLIAMS COUNTY
WHITE EARTH RIVER
1804
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 68

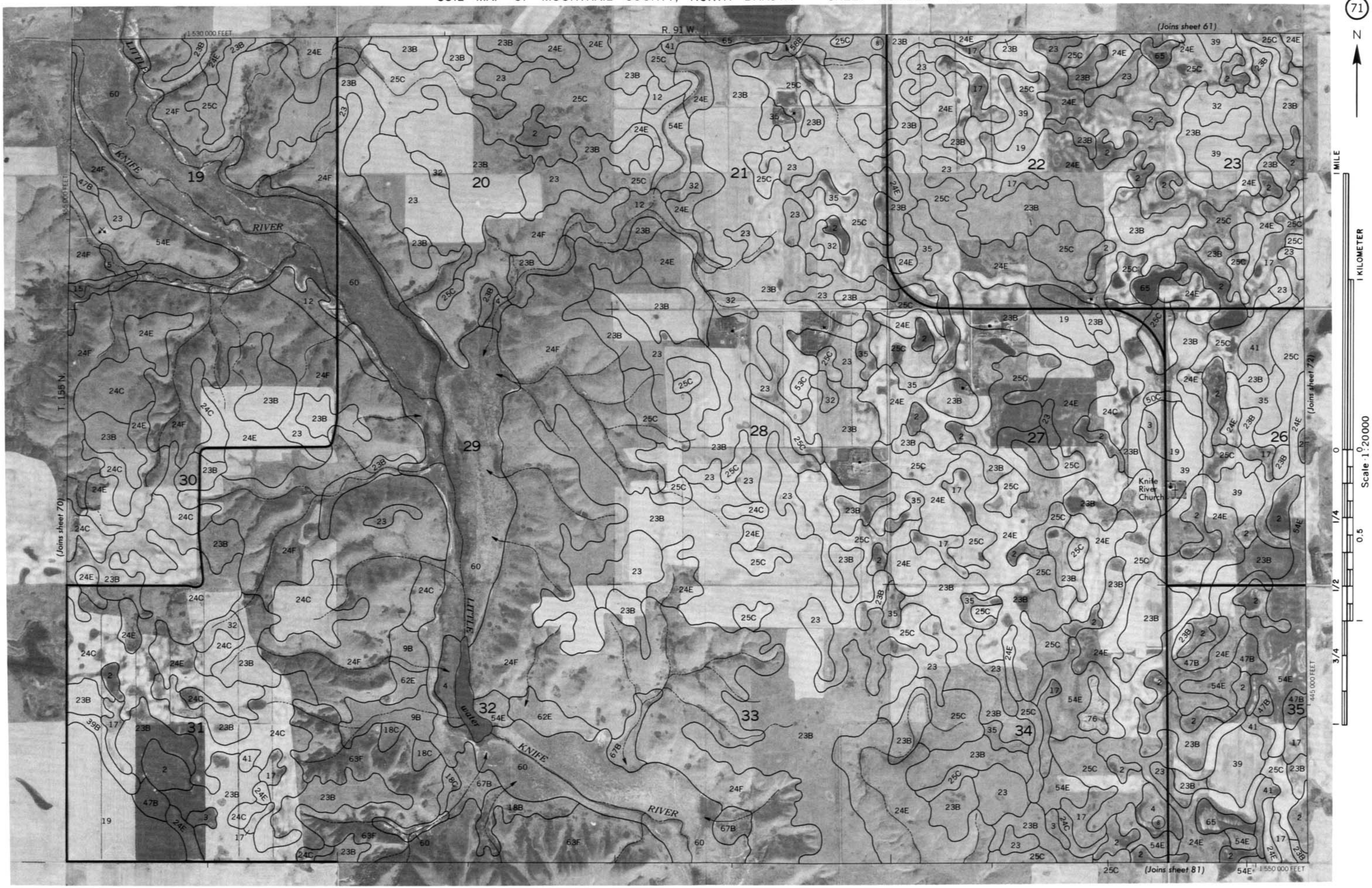


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 69

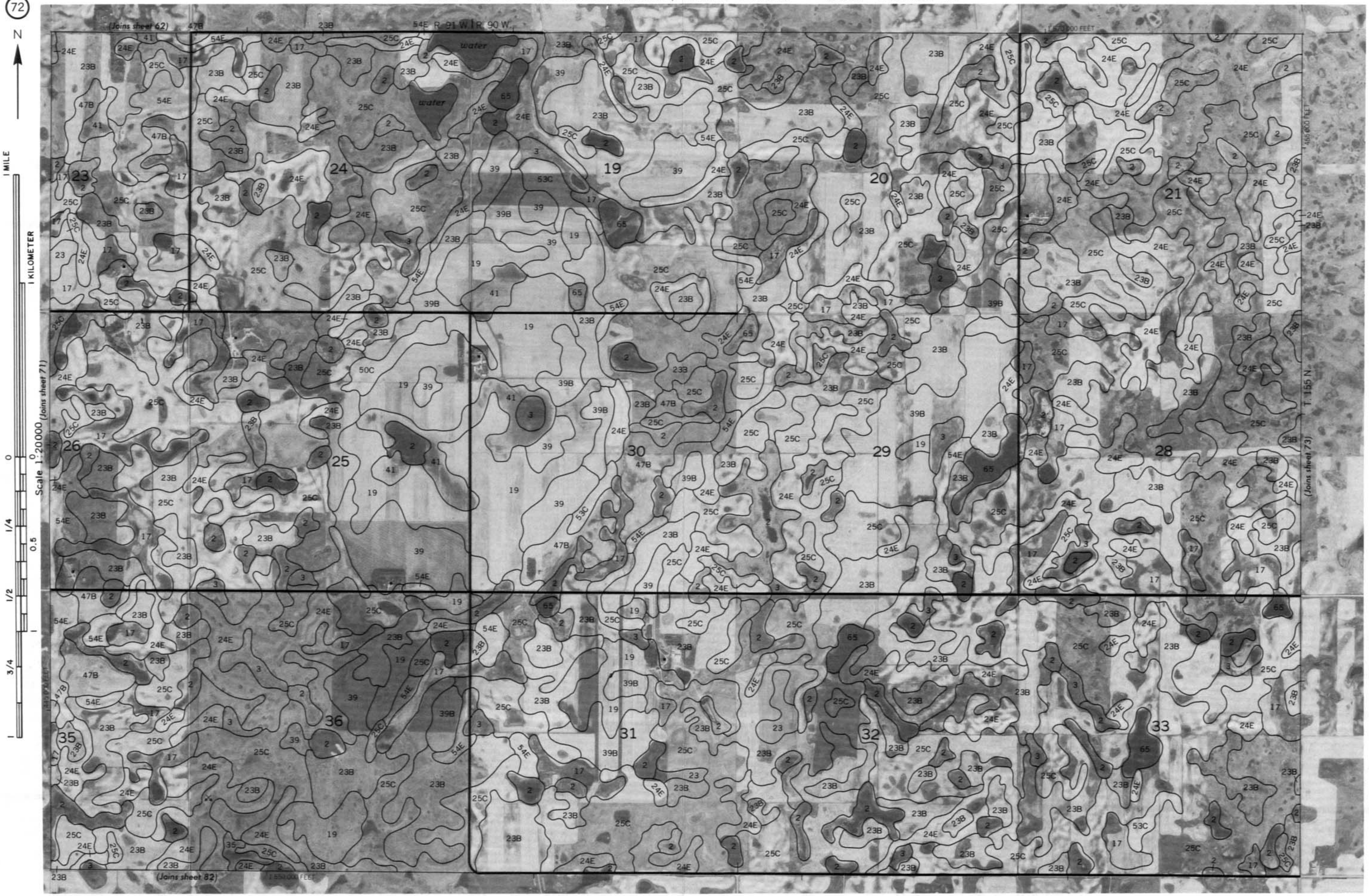



N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 60)
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 80)
R. 92 W.
T. 155 N.
1 525 000 FEET
1 505 000 FEET
445 000 FEET
water
Scandia Valley Church
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

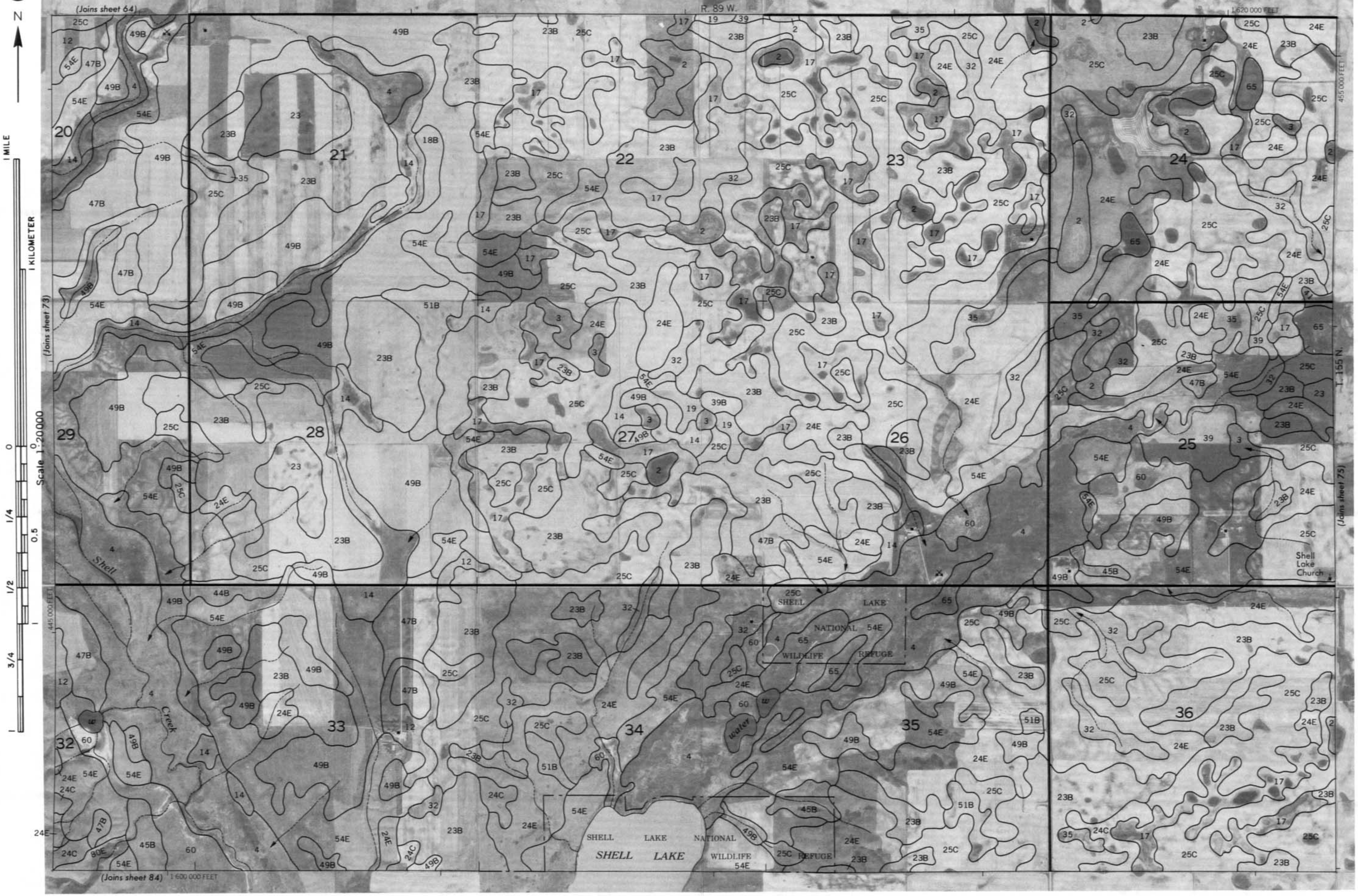
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 71



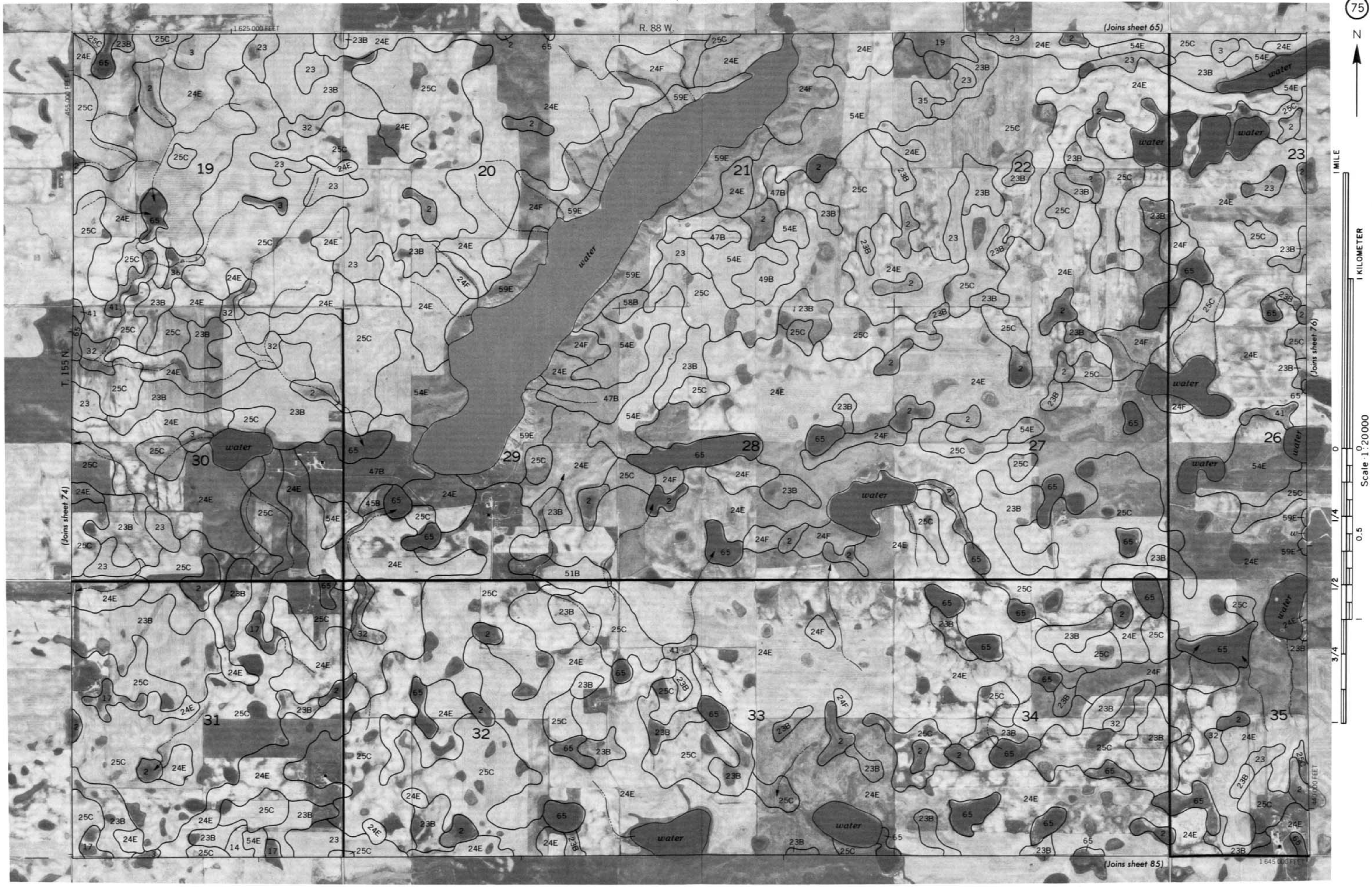
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 72



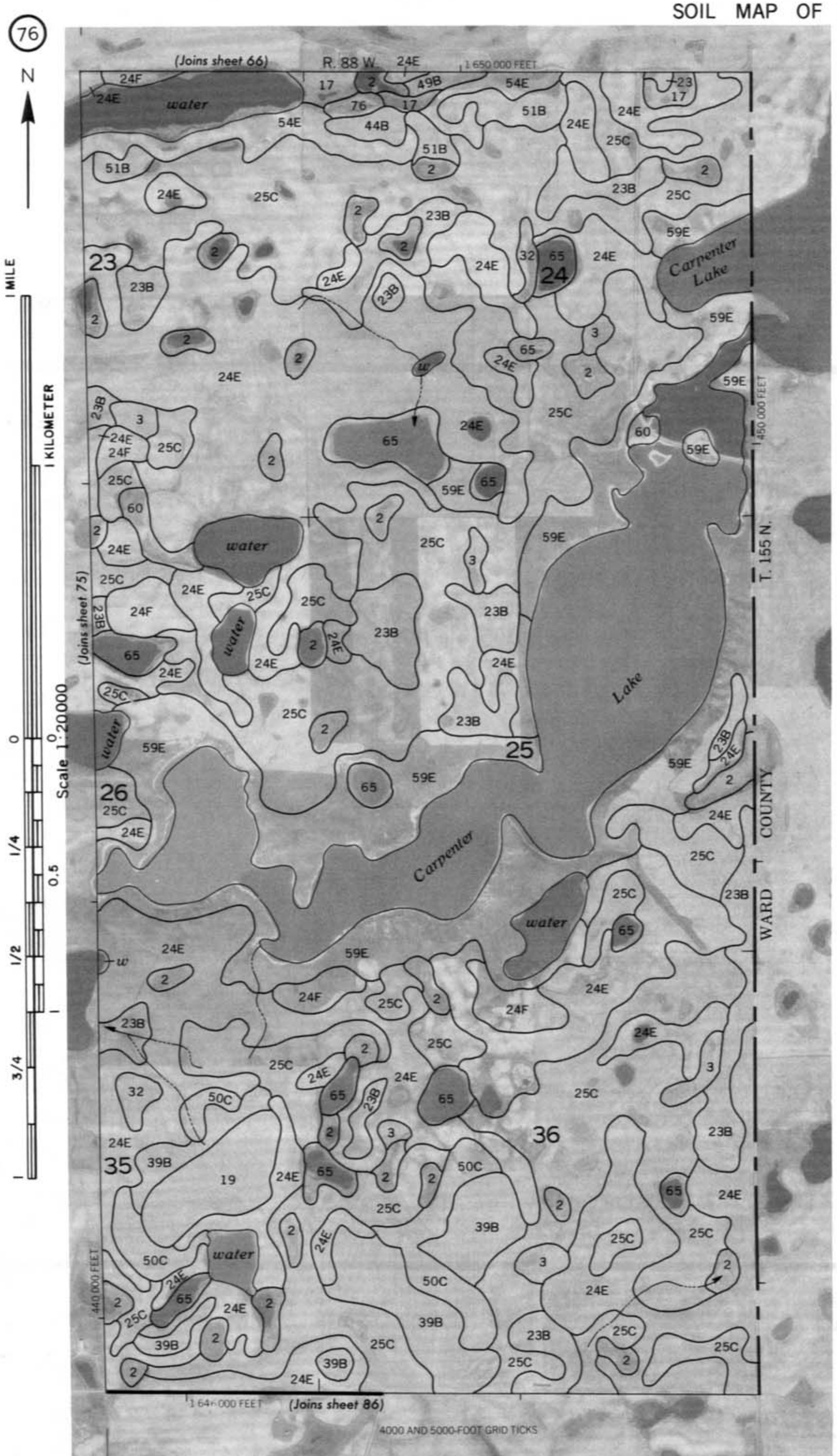
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 73


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 64)
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 84)
R. 89 W.
T. 155 N.
1 620 000 FEET
1 600 000 FEET
455 000 FEET
445 000 FEET
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
SHELL LAKE NATIONAL WILDLIFE REFUGE
SHELL LAKE
Shell Creek
Shell Lake Church
water

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 75

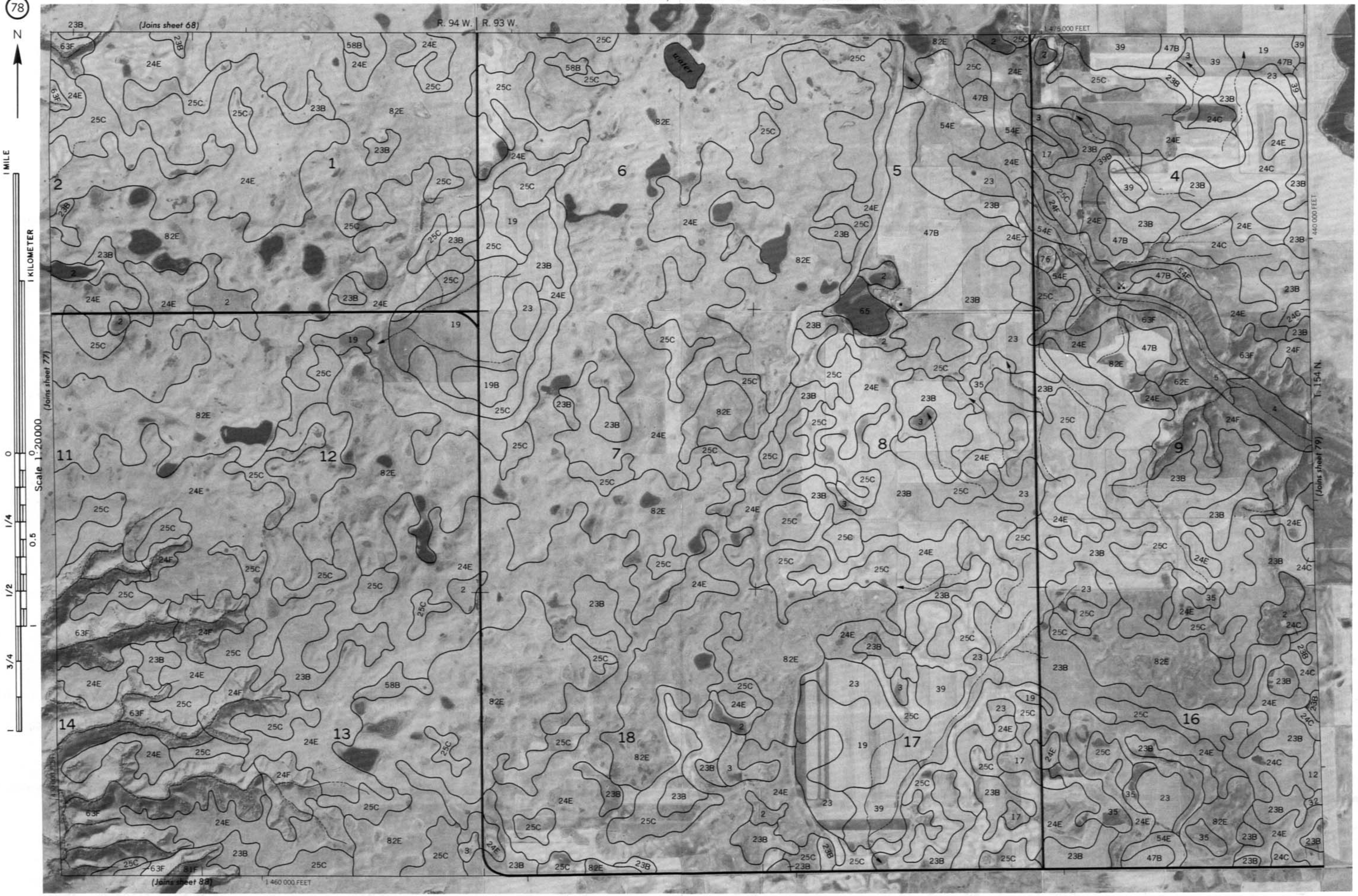


76


N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 66)
R. 88 W.
1 650 000 FEET
(Joins sheet 75)
T. 155 N.
1 450 000 FEET
WARD COUNTY
Carpenter Lake
Lake
Carpenter
water
440 000 FEET
1 640 000 FEET
(Joins sheet 86)
4000 AND 5000-FOOT GRID TICKS
23
24
25
26
35
36

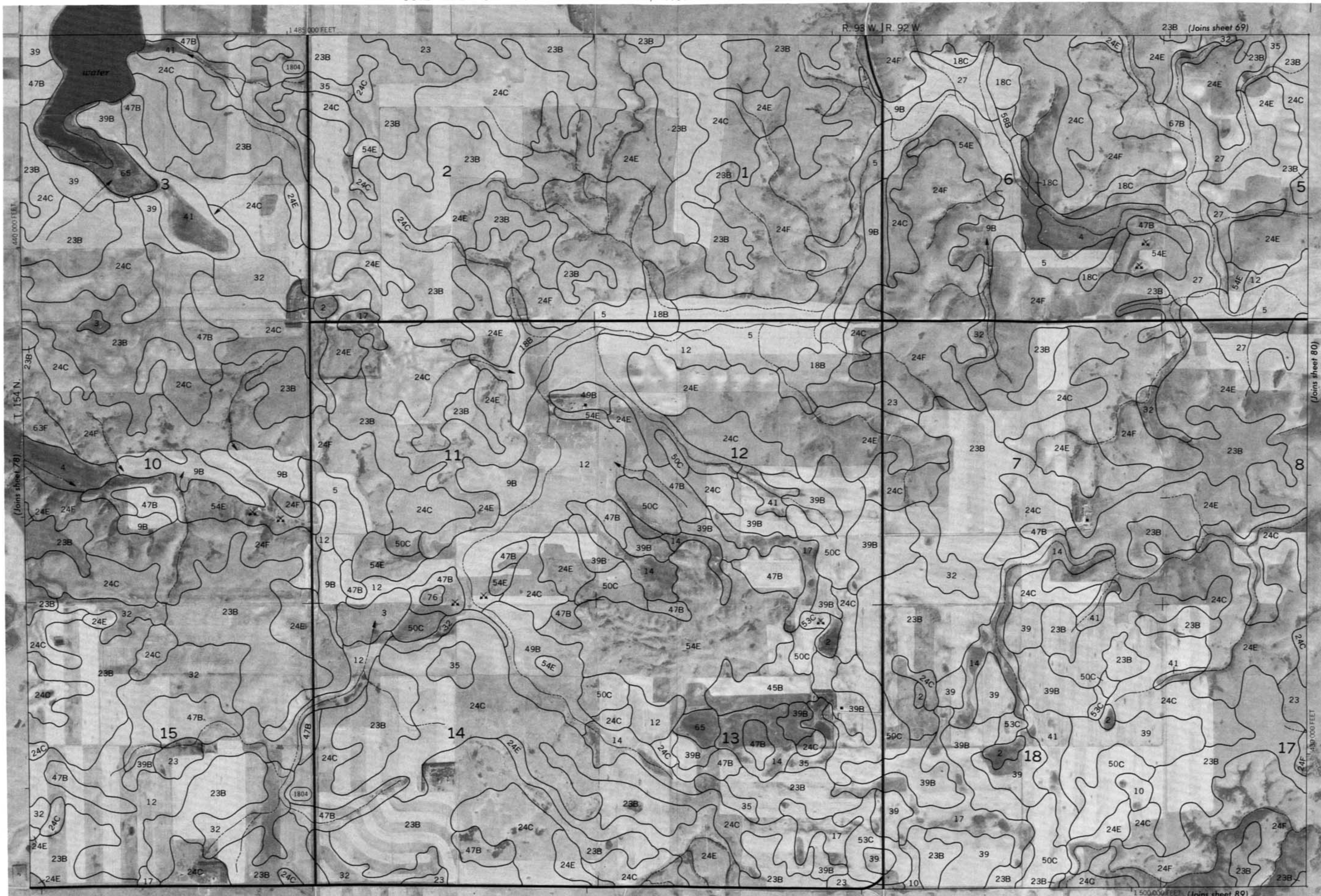

(Joins inset, sheet 66)
R. 94 W.
1 430 000 FEET
T. 157 N.
(Joins sheet 28)
WILLIAMS COUNTY
515 000 FEET
1 425 000 FEET
BURLINGTON
NORTHERN
Creek
Paulson
19
20
21
28
29
30
31
32
33

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 77

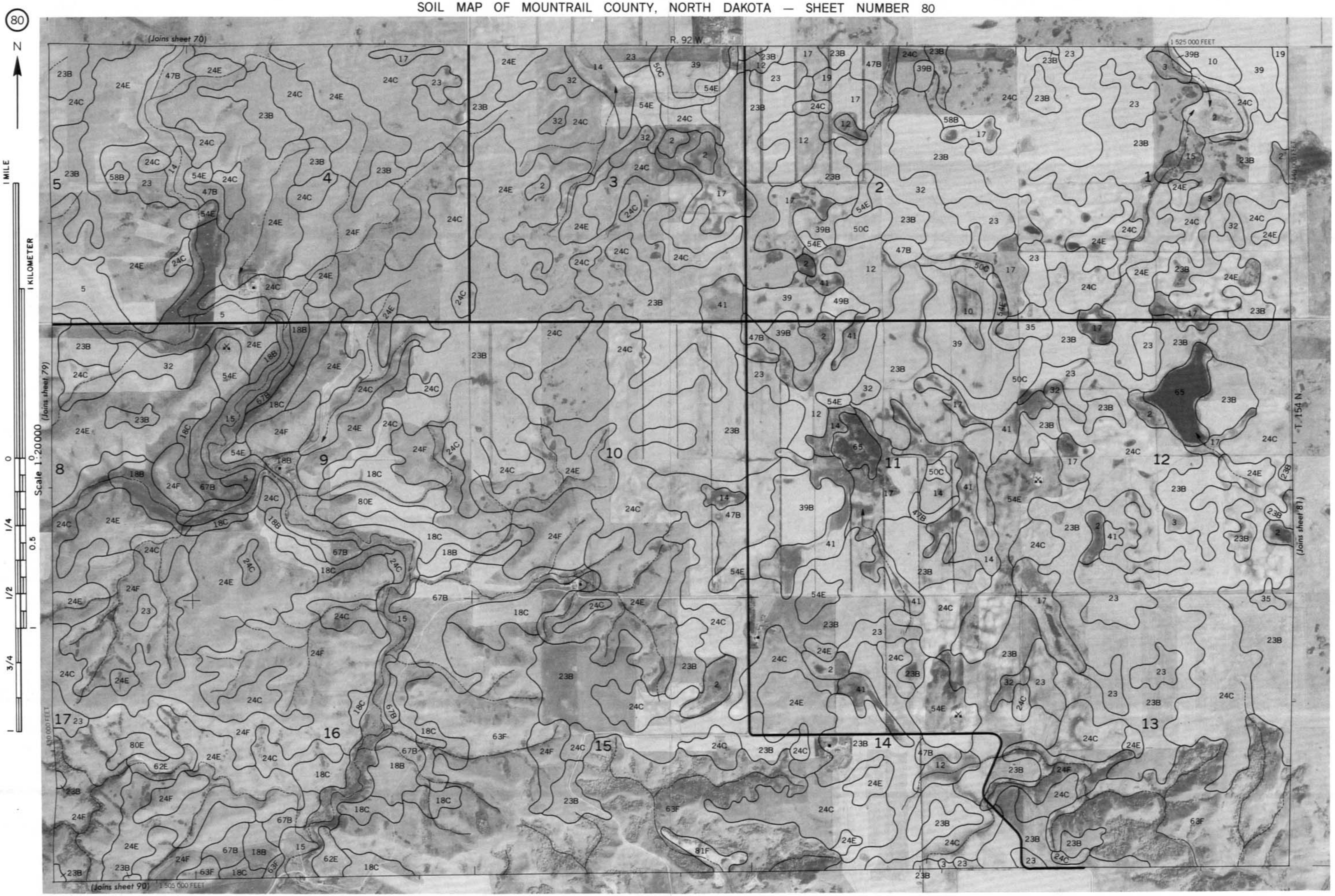

78
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 68)
R. 94 W.
R. 93 W.
1 475 000 FEET
440 000 FEET
T. 154 N.
(Joins sheet 77)
(Joins sheet 79)
(Joins sheet 83)
1 460 000 FEET
water
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

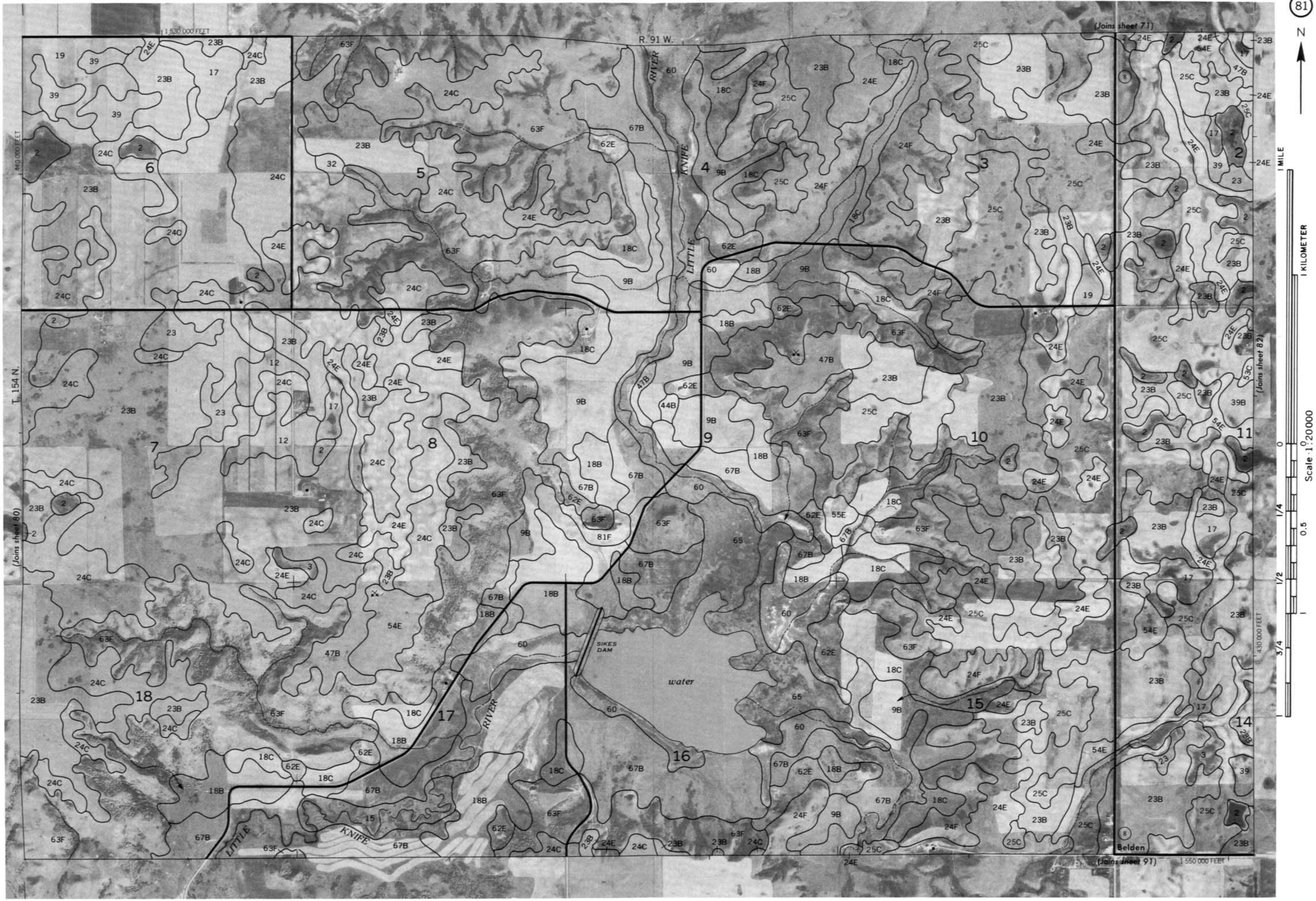
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 79

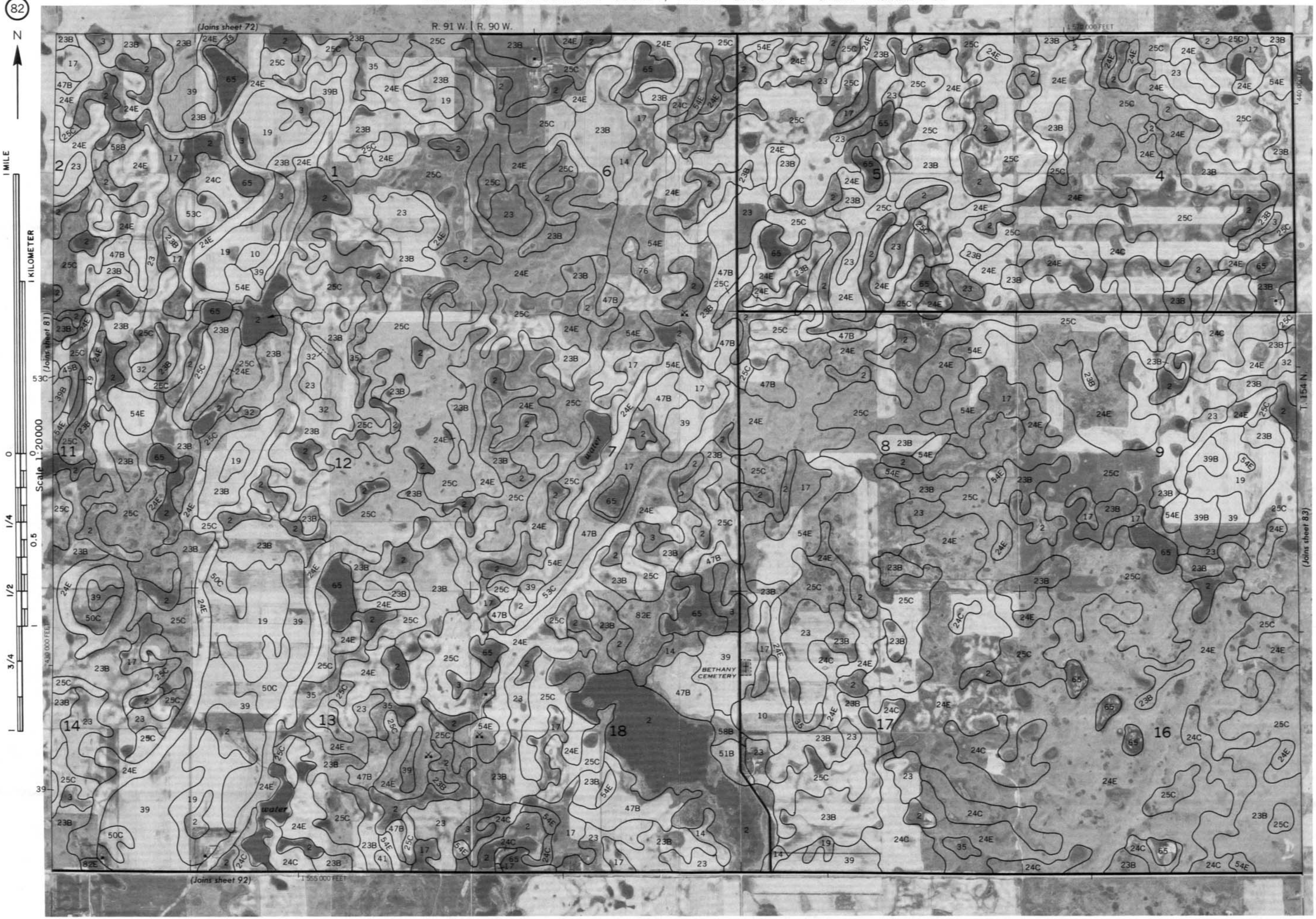
79



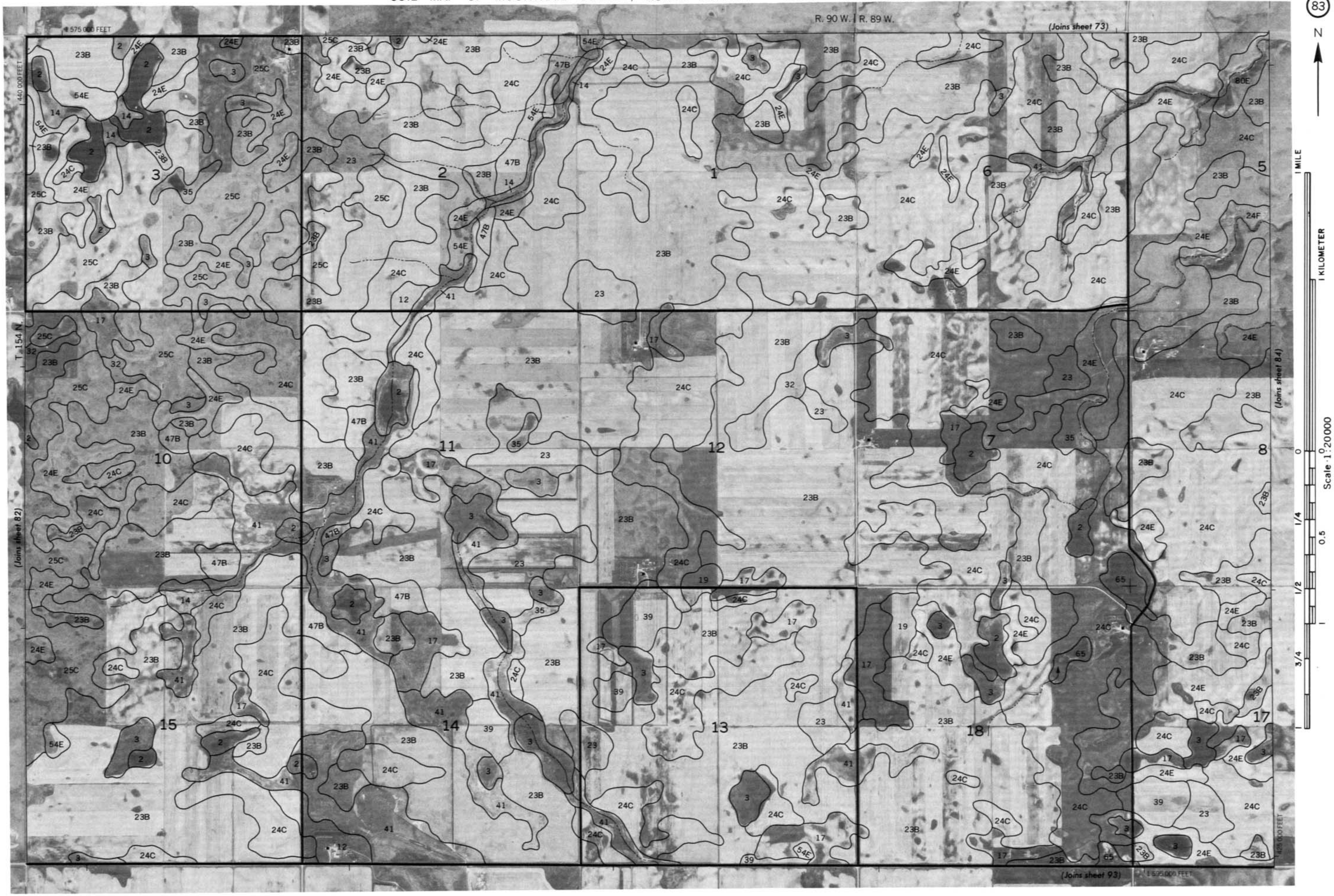
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 80




81
N
(Joins sheet 71)
R. 91 W.
1 530 000 FEET
T. 154 N.
(Joins sheet 80)
(Joins sheet 82)
(Joins sheet 91)
1 550 000 FEET
430 000 FEET
LITTLE KNIFE RIVER
SIKES DAM
water
Belden
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5

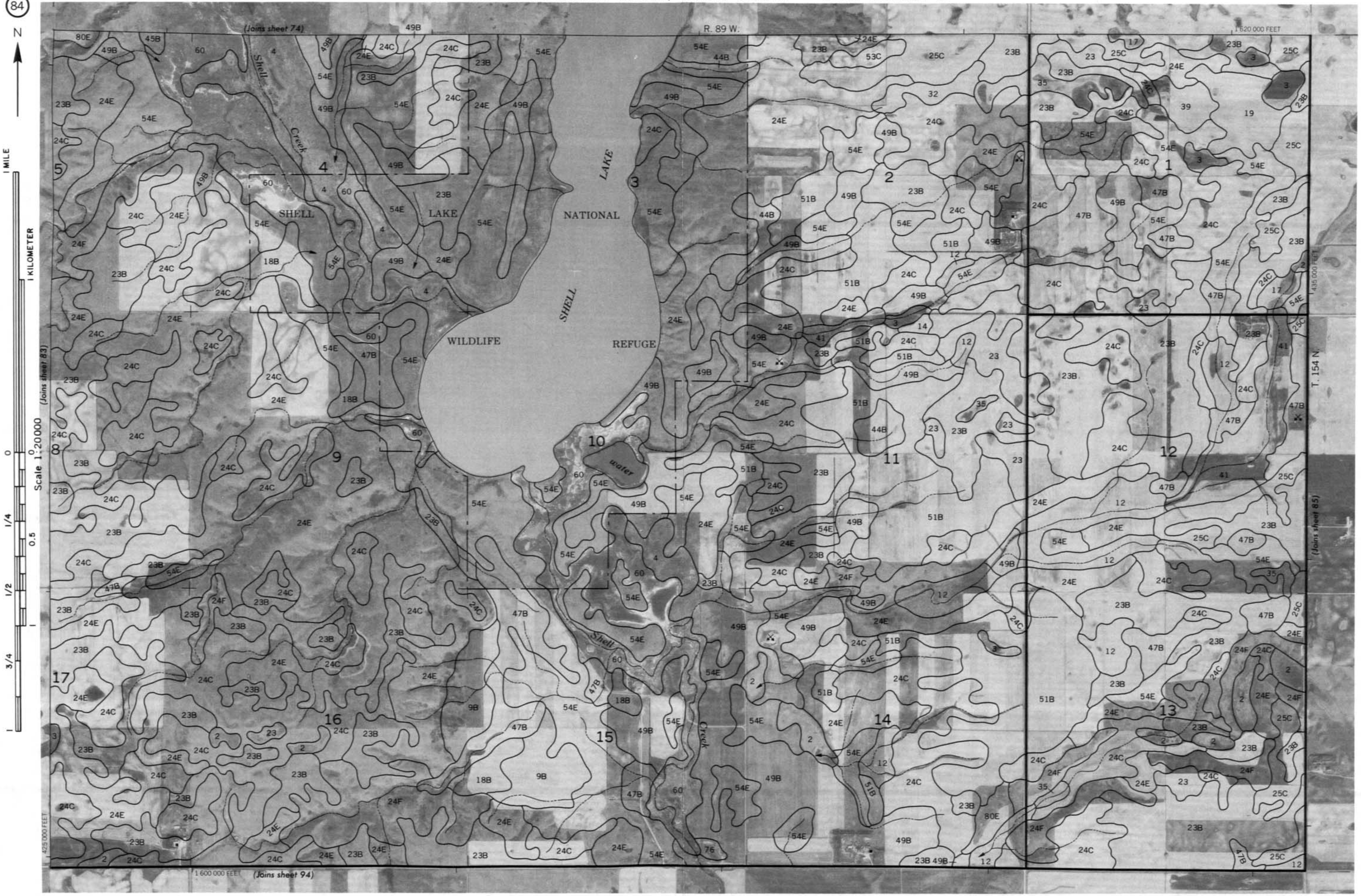

82
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 72)
R. 91 W. | R. 90 W.
1 570 000 FEET
440 000 FEET
(Joins sheet 81)
(Joins sheet 83)
T. 154 N.
(Joins sheet 92)
1 555 000 FEET
430 000 FEET
BETHANY CEMETERY
water

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 83

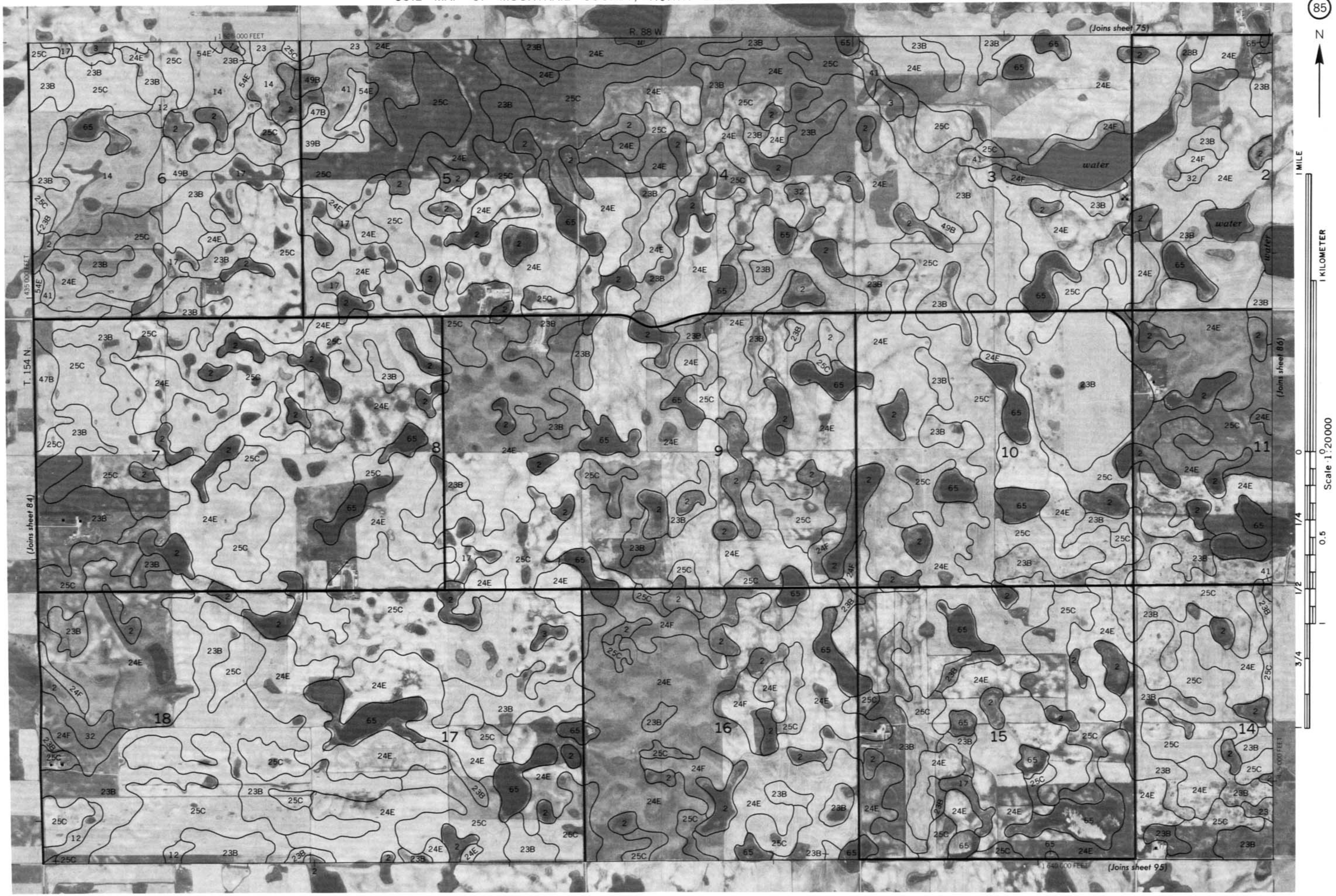


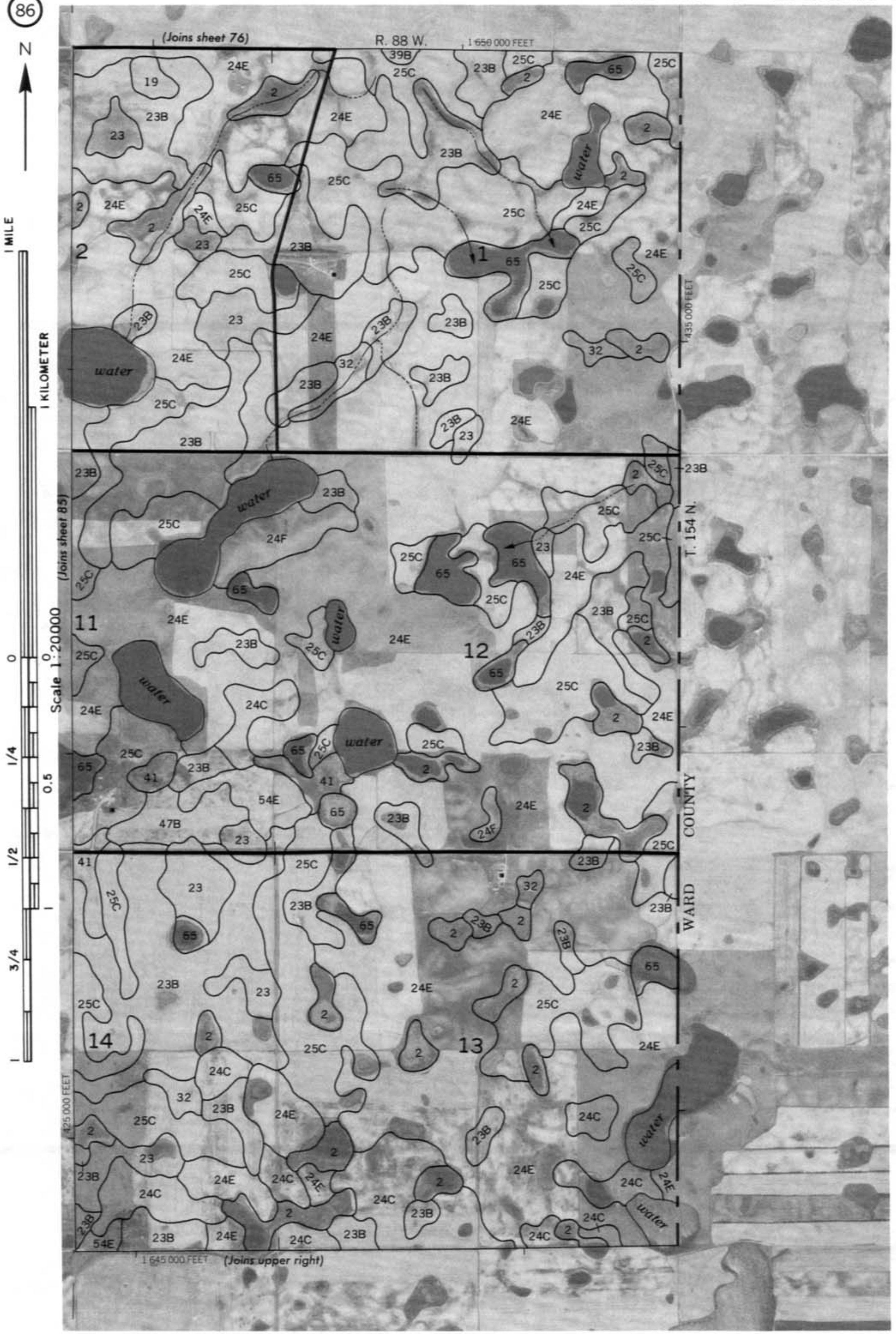
84

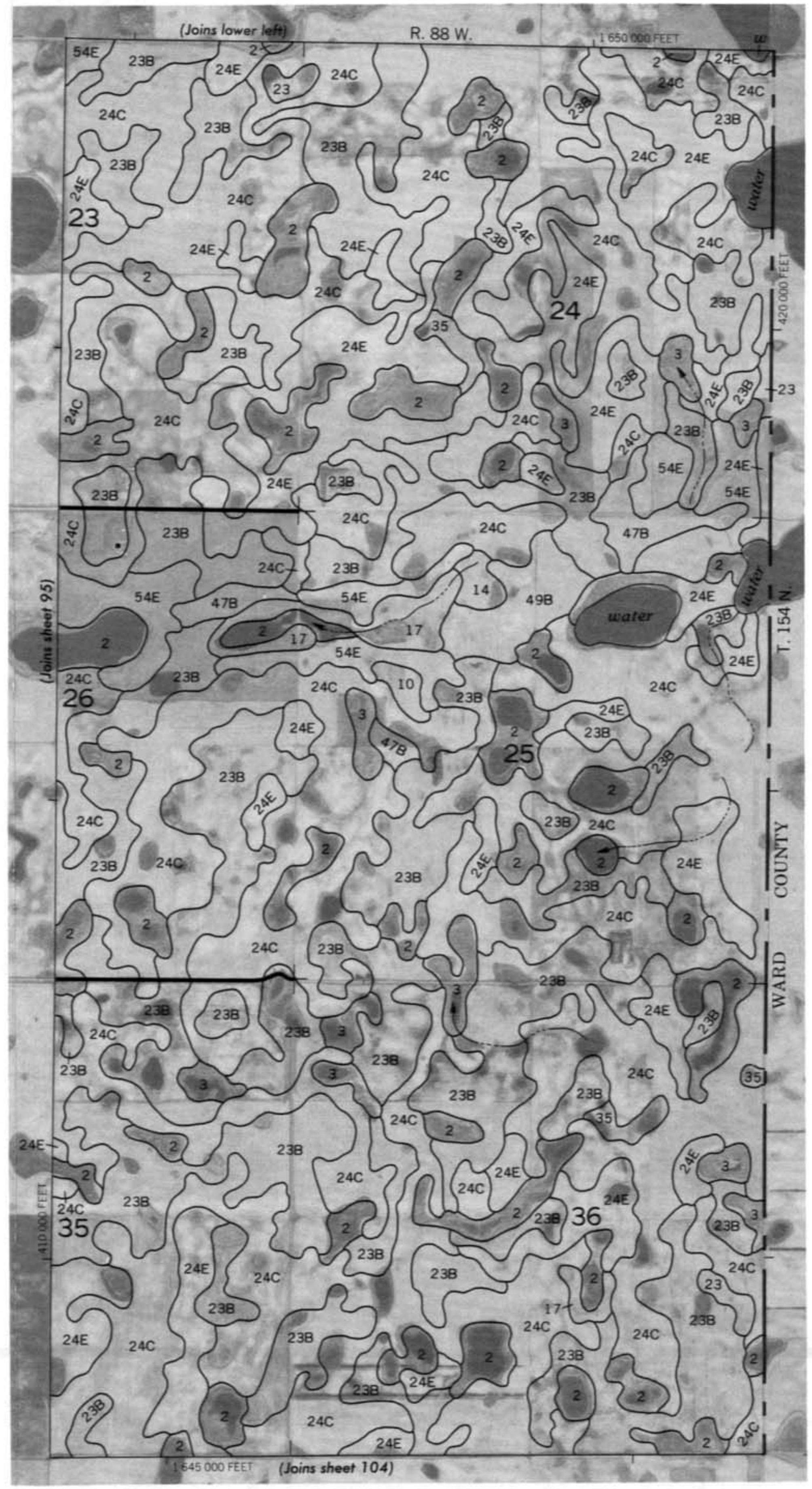
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 84

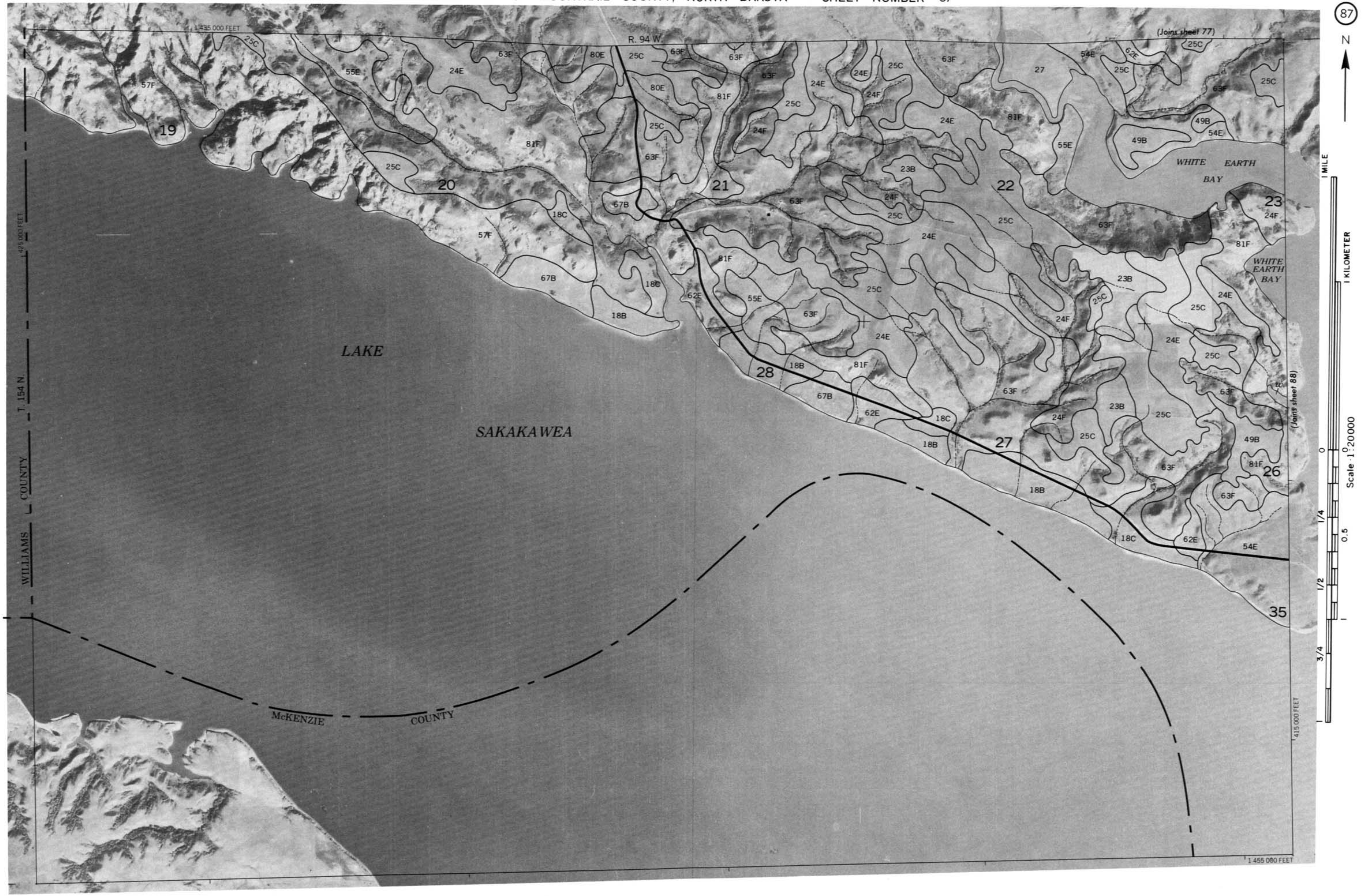


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 85

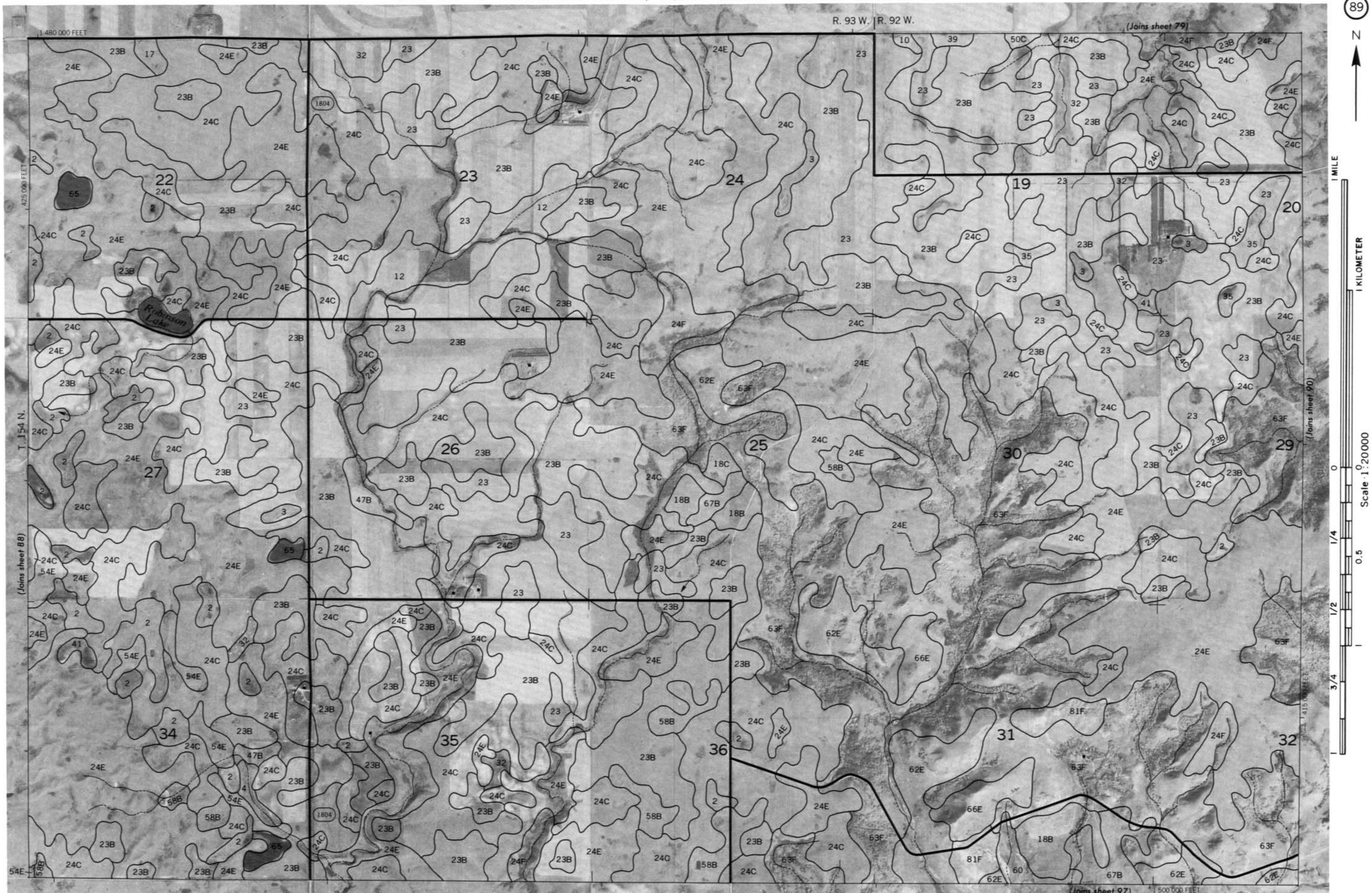



N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 76)
R. 88 W.
1 650 000 FEET
435 000 FEET
(Joins sheet 85)
T. 154 N.
WARD COUNTY
425 000 FEET
1 645 000 FEET
(Joins upper right)
water


(Joins lower left)
R. 88 W.
1 650 000 FEET
420 000 FEET
(Joins sheet 95)
T. 154 N.
WARD COUNTY
410 000 FEET
1 645 000 FEET
(Joins sheet 104)
water

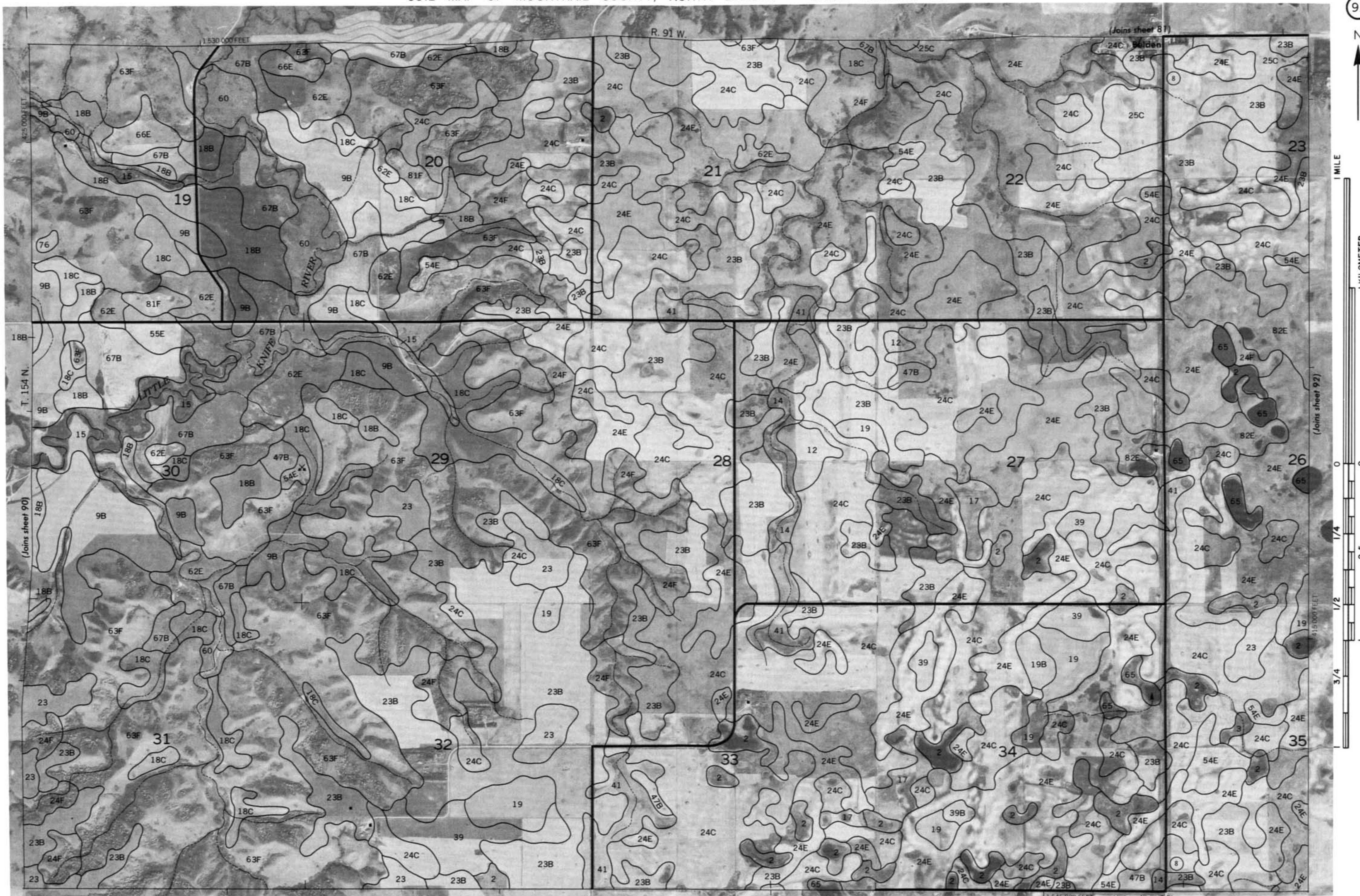

87
N
(Joins sheet 77)
(Joins sheet 88)
R. 94 W.
T. 154 N.
WILLIAMS COUNTY
McKENZIE COUNTY
LAKE SAKAKAWEA
WHITE EARTH BAY
1 435 000 FEET
1 455 000 FEET
475 000 FEET
415 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
19
20
21
22
23
26
27
28
35

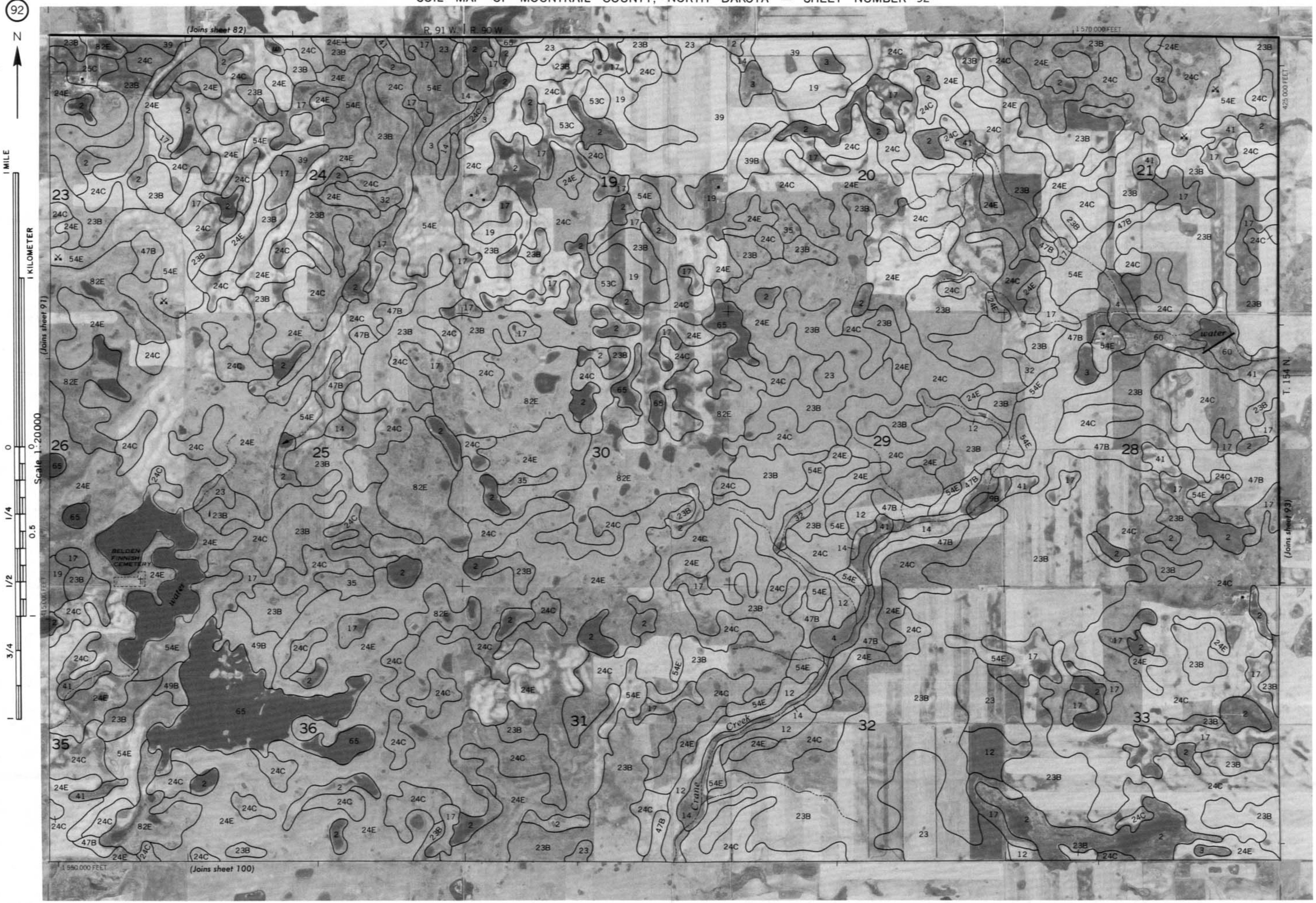

88
N
(Joins sheet 78)
R. 94 W. | R. 93 W.
1 475 000 FEET
WHITE
EARTH
BAY
LAKE
SAKAKAWEA
(Joins sheet 87)
(Joins sheet 89)
(Joins sheet 96)
1 460 000 FEET
T. 154 N.
1 MILE
1 KILOMETER
Scale 1:20000
water


N
R. 93 W. | R. 92 W.
(Joins sheet 79)
(Joins sheet 88)
(Joins sheet 90)
(Joins sheet 97)
T. 154 N.
1 480 000 FEET
425 000 FEET
415 000 FEET
1 500 000 FEET
Robinson Lake
1804
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

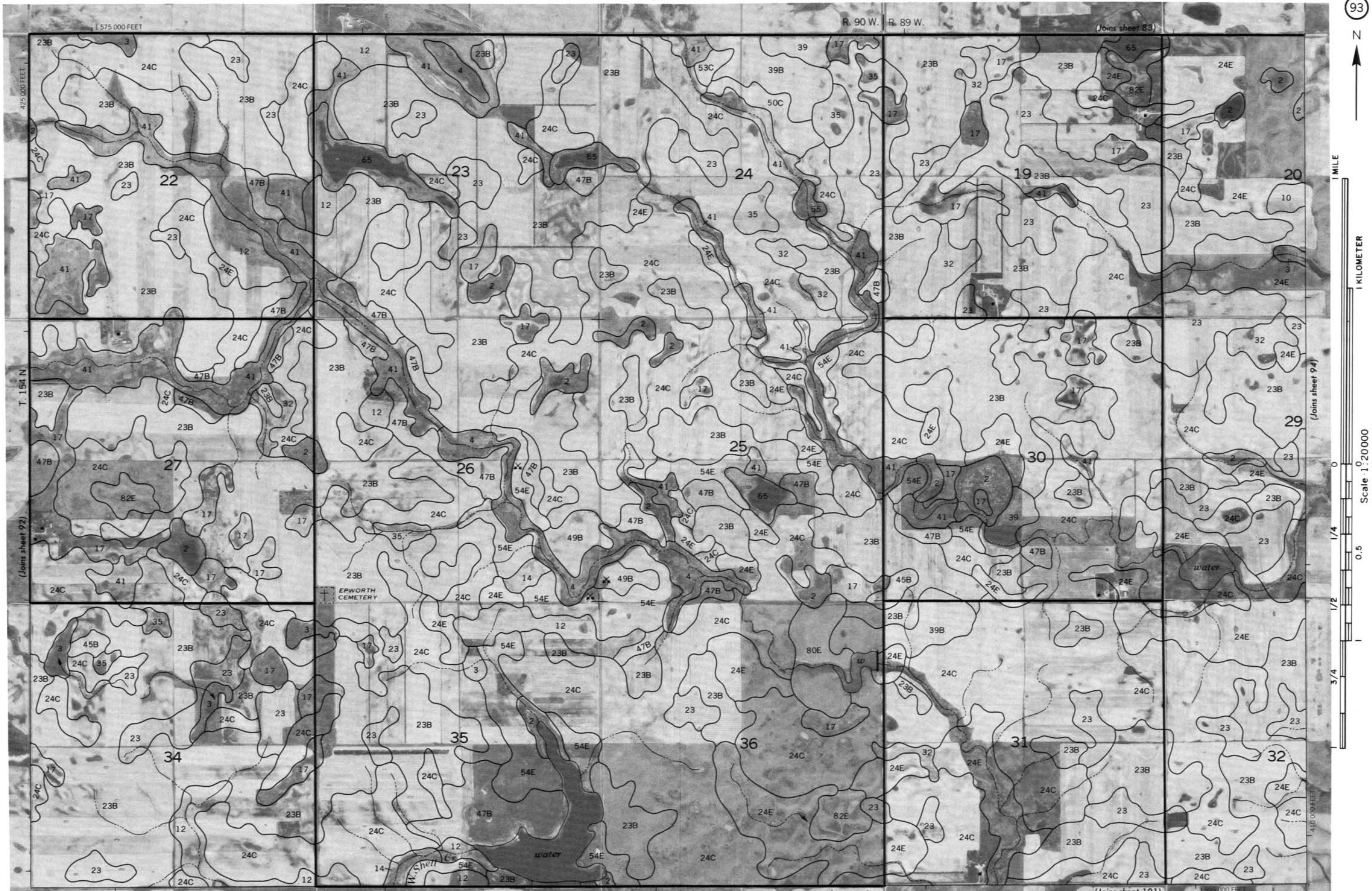
90

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 90

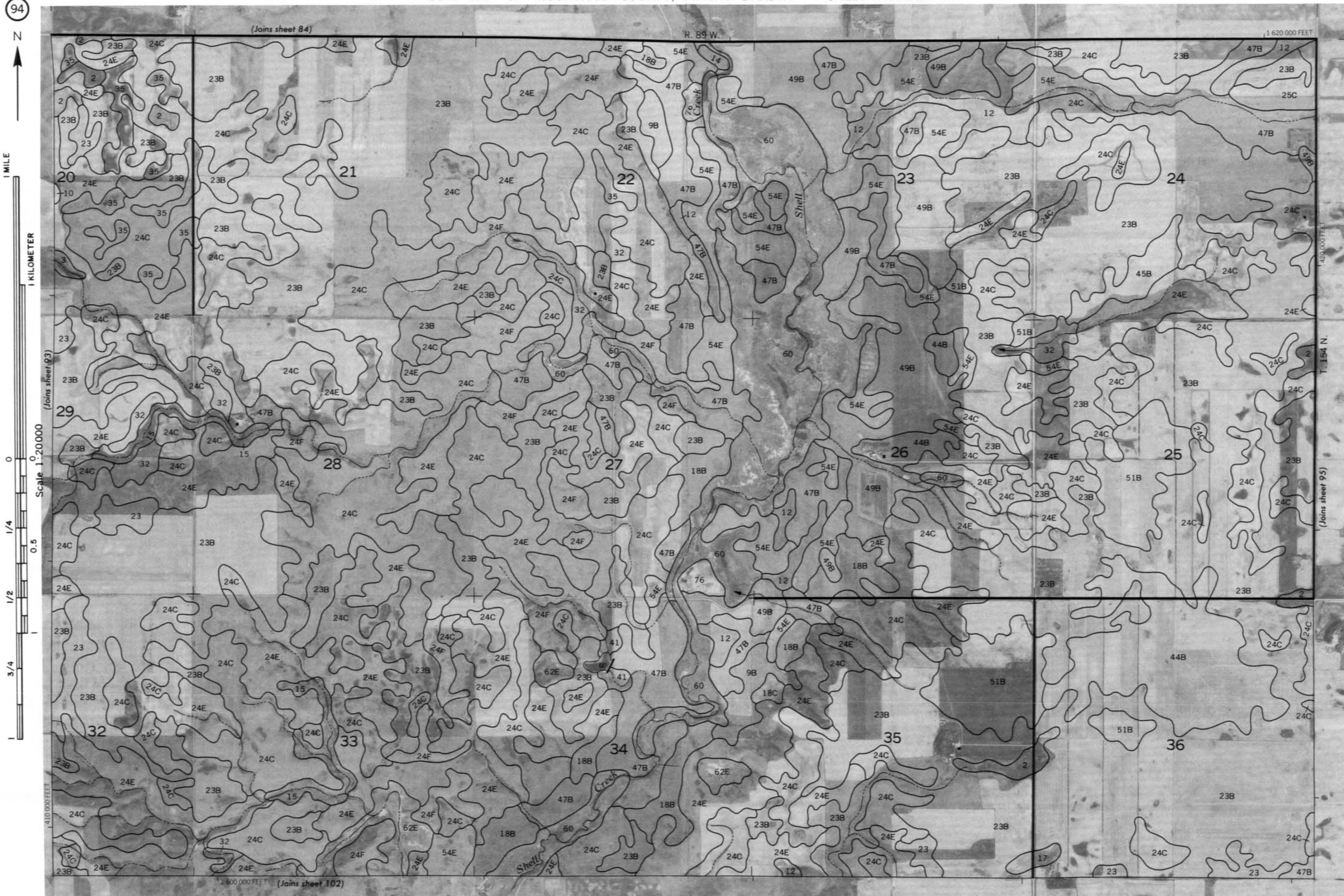

91
N
(Joins sheet 81)
R. 91 W.
1 530 000 FEET
425 000 FEET
Belden
T. 154 N.
(Joins sheet 90)
(Joins sheet 92)
(Joins sheet 99)
1 545 000 FEET
415 000 FEET
LITTLE
KNIFE
RIVER
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1


92
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 82)
R. 91 W.
R. 90 W.
1 570 000 FEET
425 000 FEET
T. 154 N.
(Joins sheet 91)
(Joins sheet 93)
(Joins sheet 100)
1 550 000 FEET
BELDEN FINNISH CEMETERY
water
Crane Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

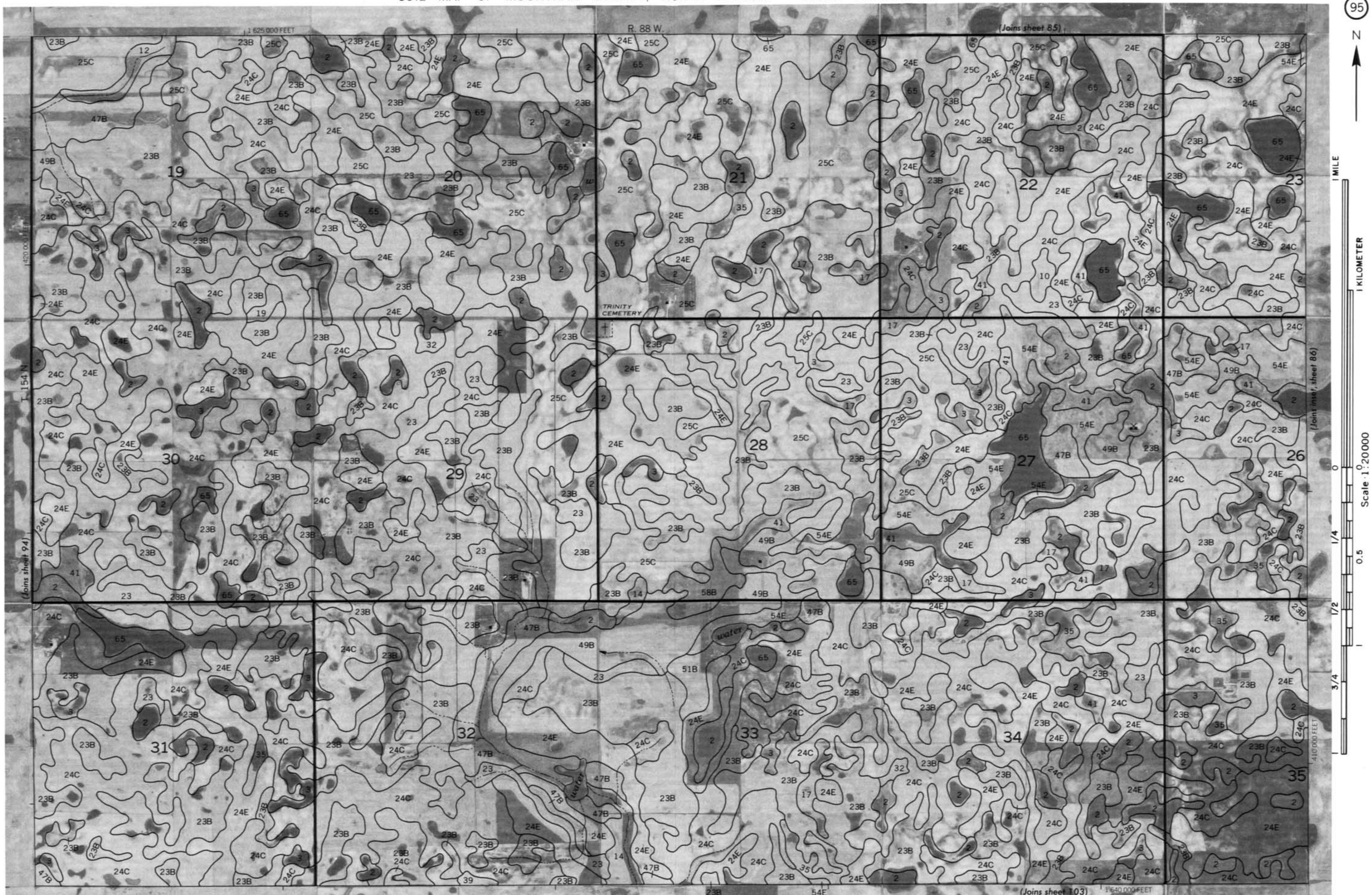
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 93

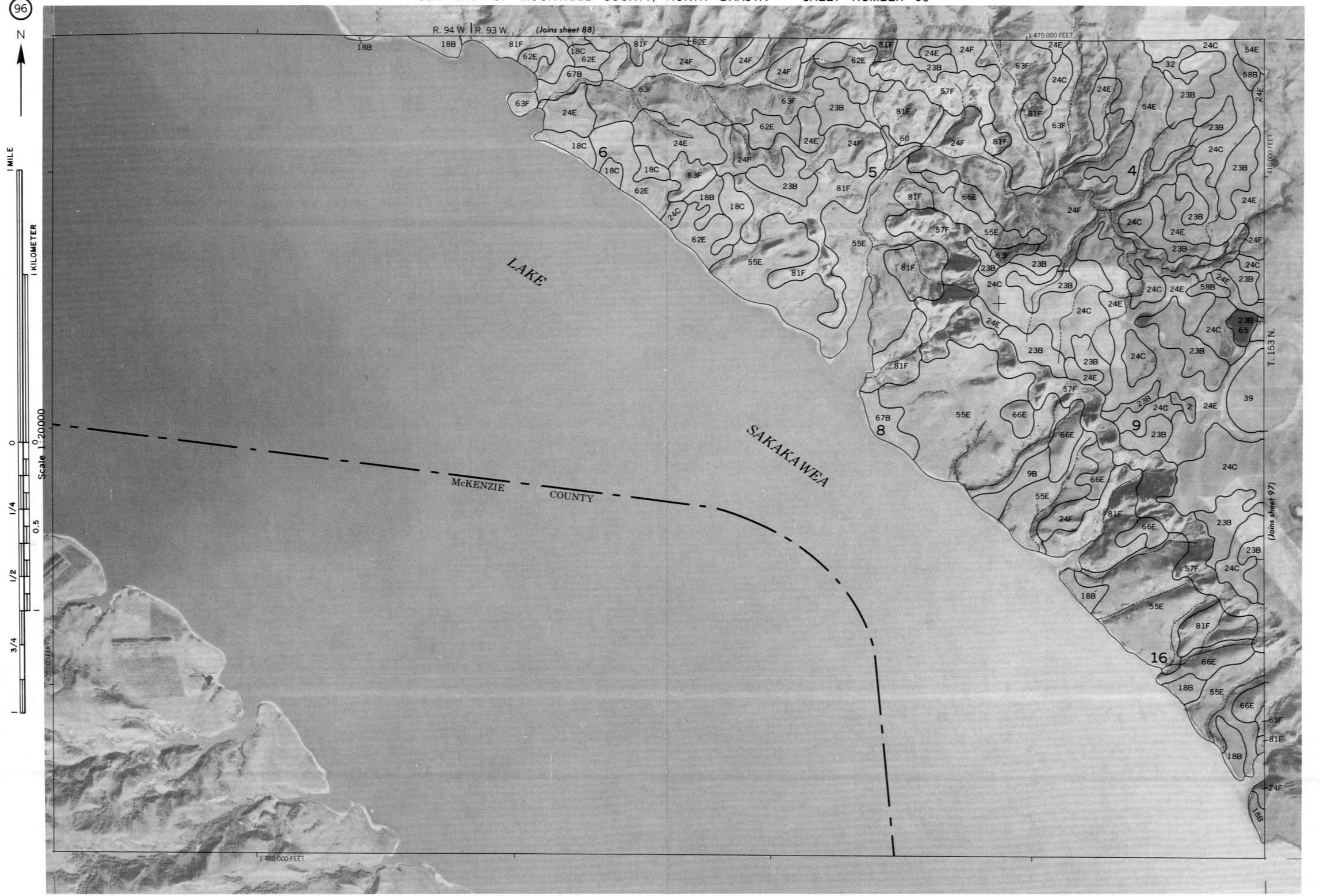


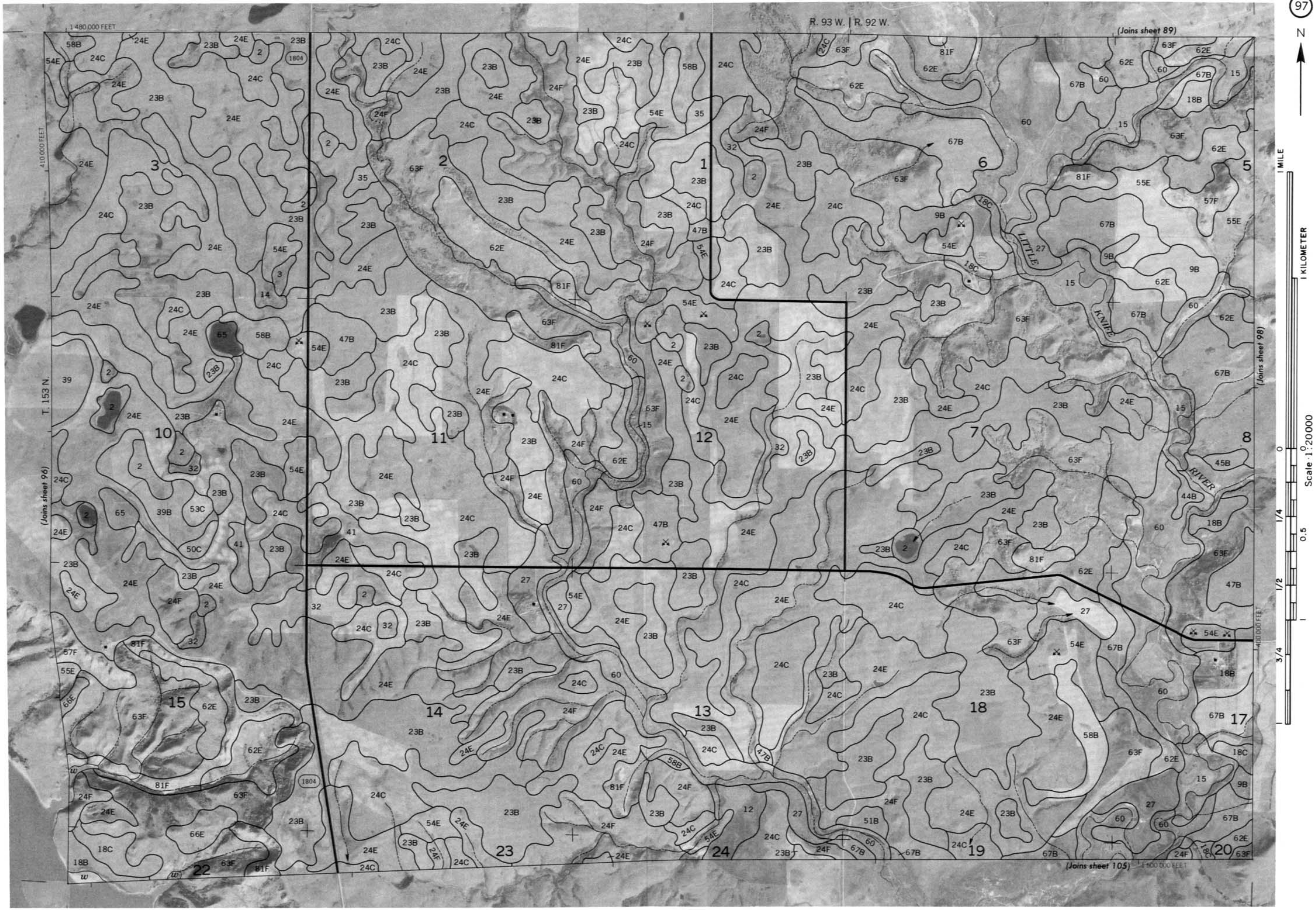
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 94

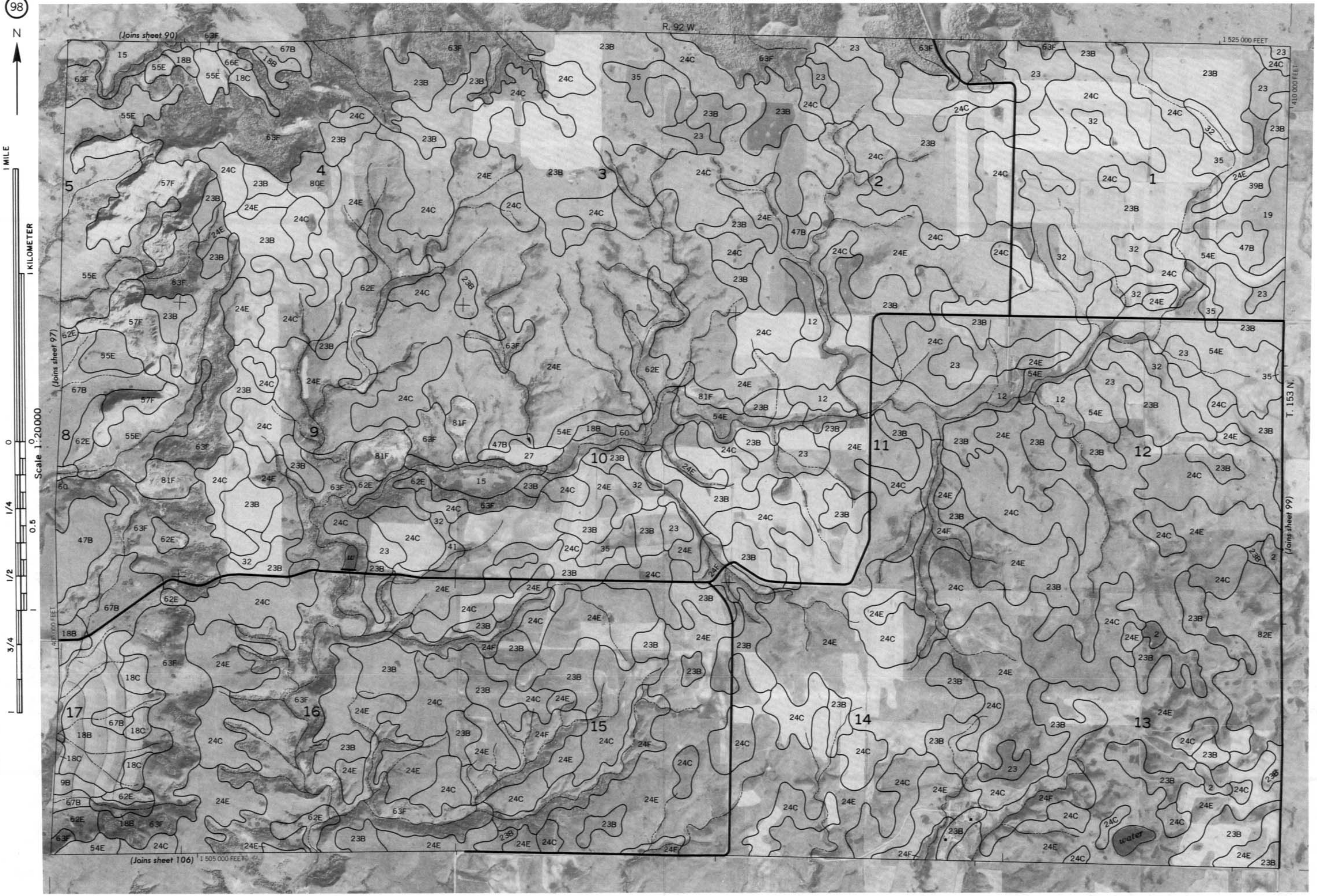


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 95

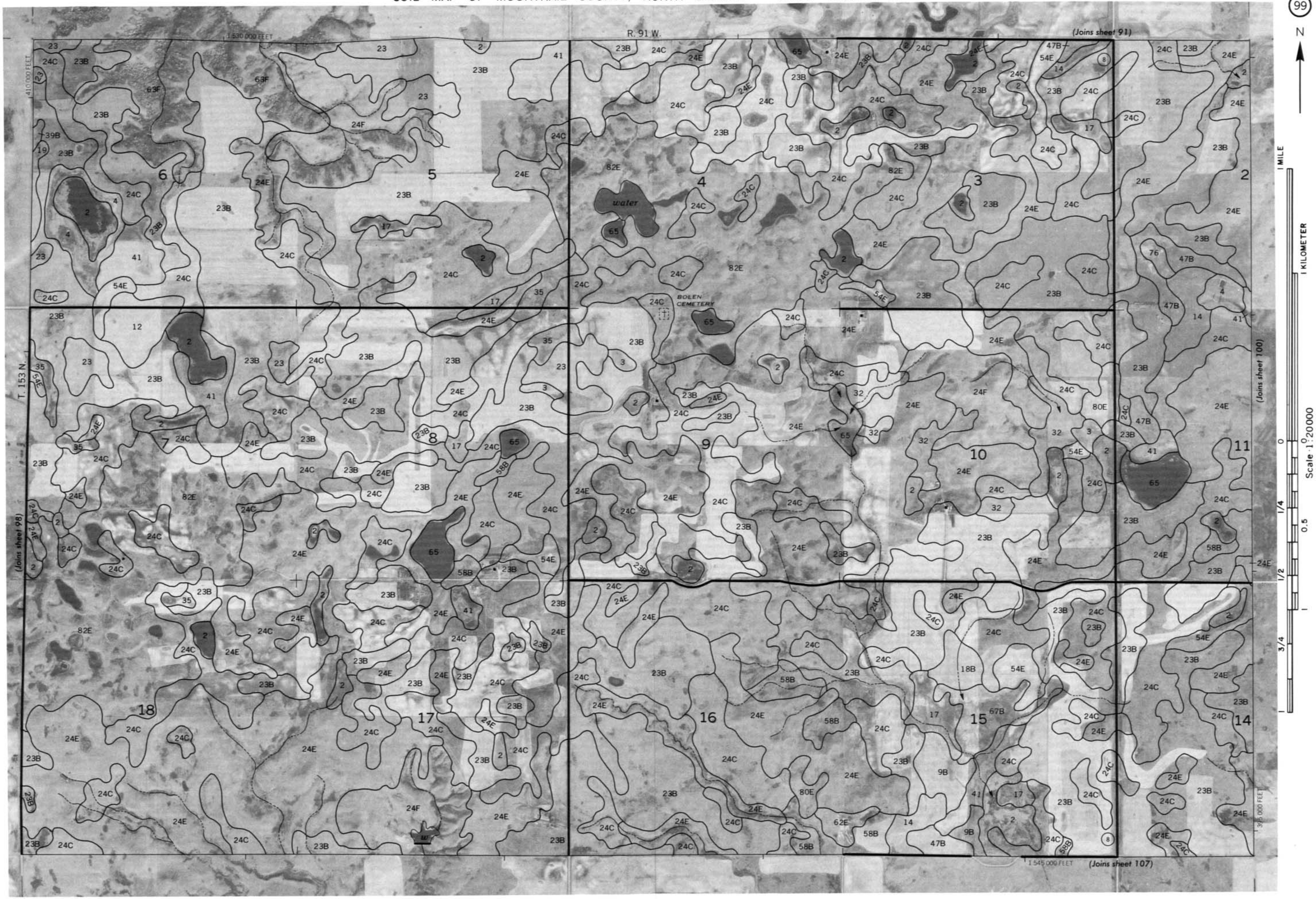



96
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
R. 94 W. | R. 93 W.
(Joins sheet 88)
1 475 000 FEET
410 000 FEET
T. 153 N.
(Joins sheet 97)
1 460 000 FEET
400 000 FEET
LAKE
SAKAKAWEA
McKENZIE
COUNTY
4
5
6
8
9
16
18B
18C
23B
24C
24E
24F
32
39
54E
55E
57F
58B
60
62E
63F
65
66E
67B
81F
9B
2

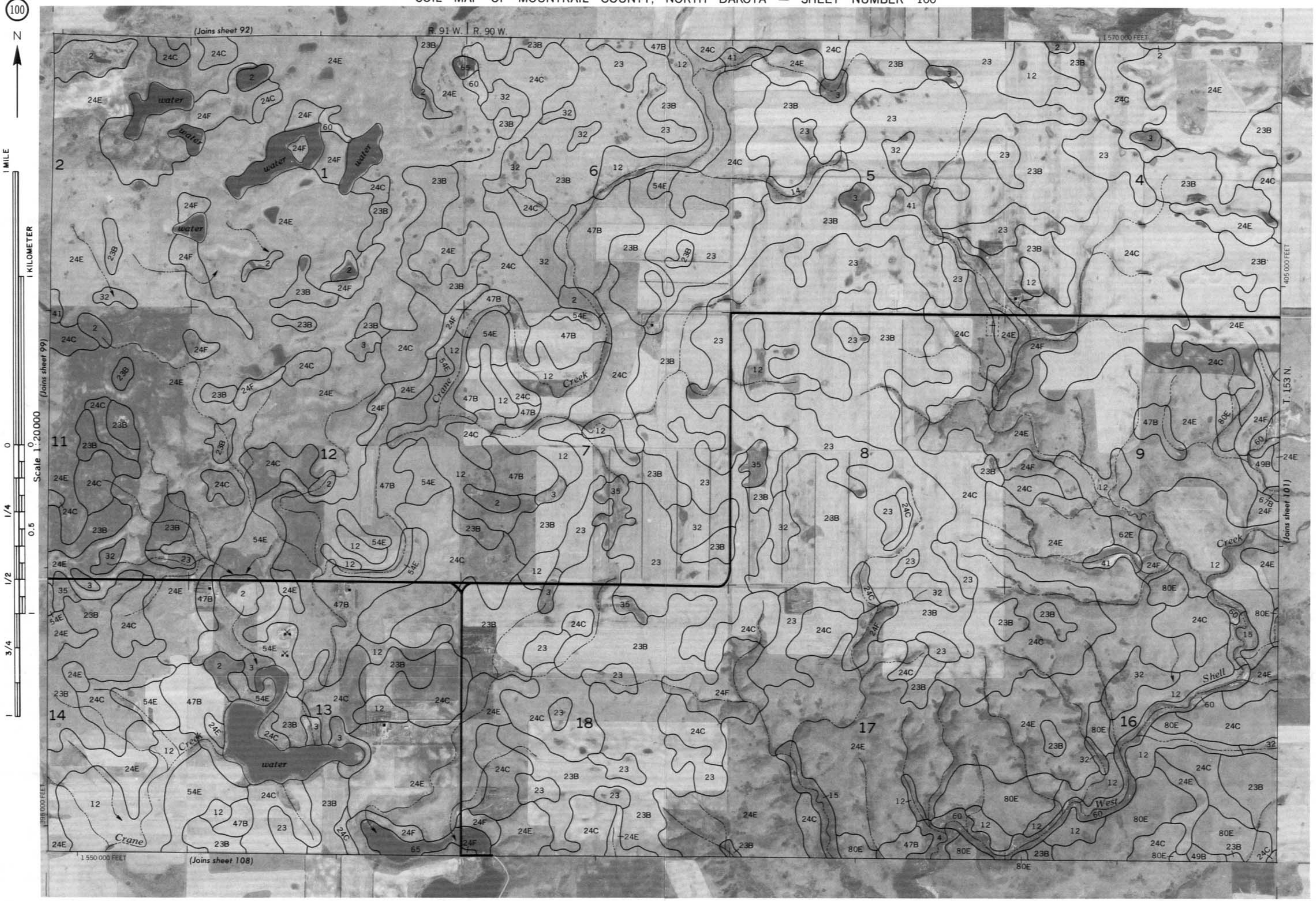

R. 93 W. | R. 92 W.
1 480 000 FEET
410 000 FEET
(Joins sheet 89)
(Joins sheet 98)
(Joins sheet 105)
(Joins sheet 96)
T. 153 N.
1 500 000 FEET
400 000 FEET
LITTLE
KNIFE
RIVER
N
1 MILE
1 KILOMETER
Scale 1:20000


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 90)
R. 92 W.
1 525 000 FEET
410 000 FEET
T. 153 N.
(Joins sheet 99)
(Joins sheet 97)
400 000 FEET
(Joins sheet 106)
1 505 000 FEET
water

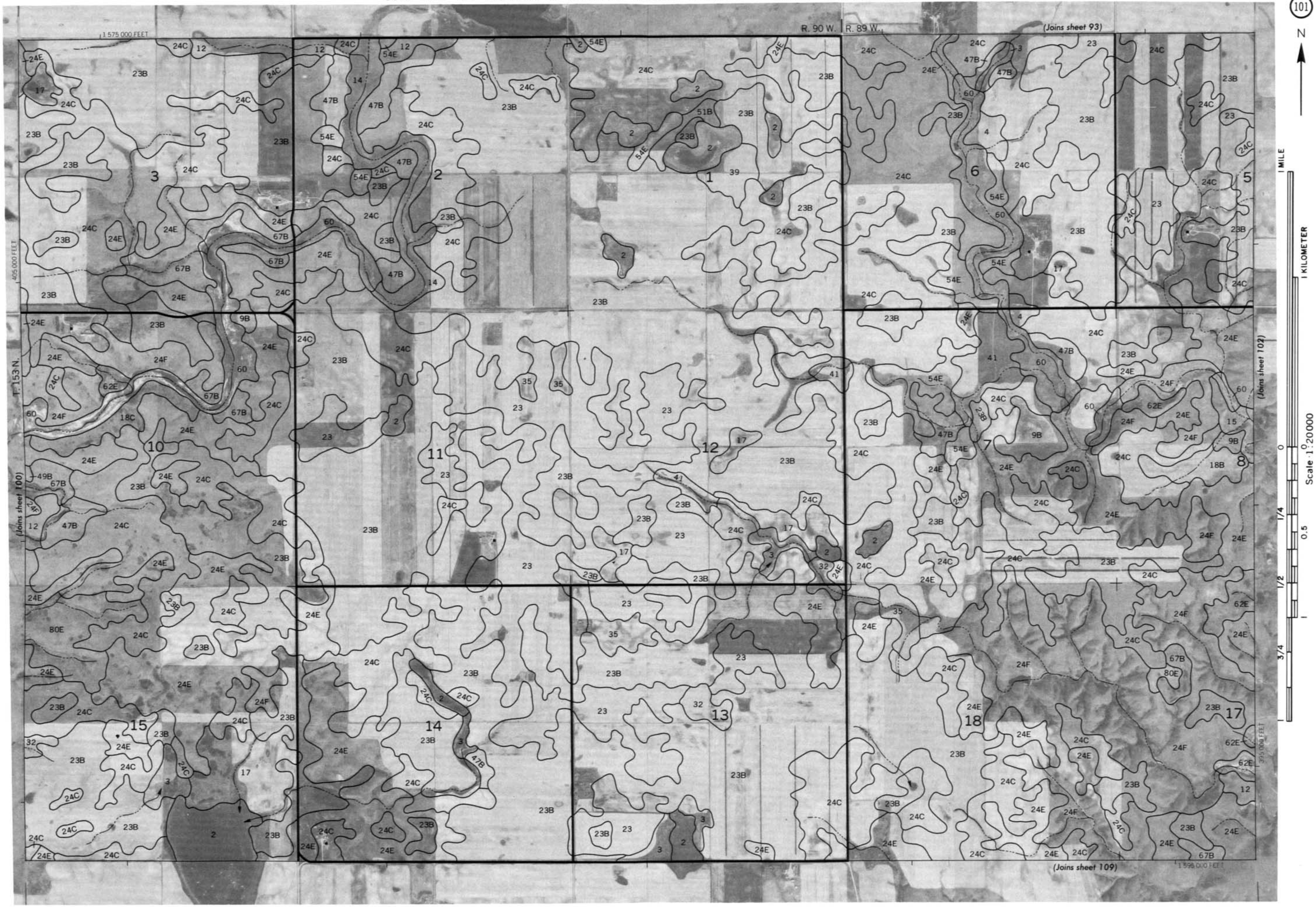
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 99

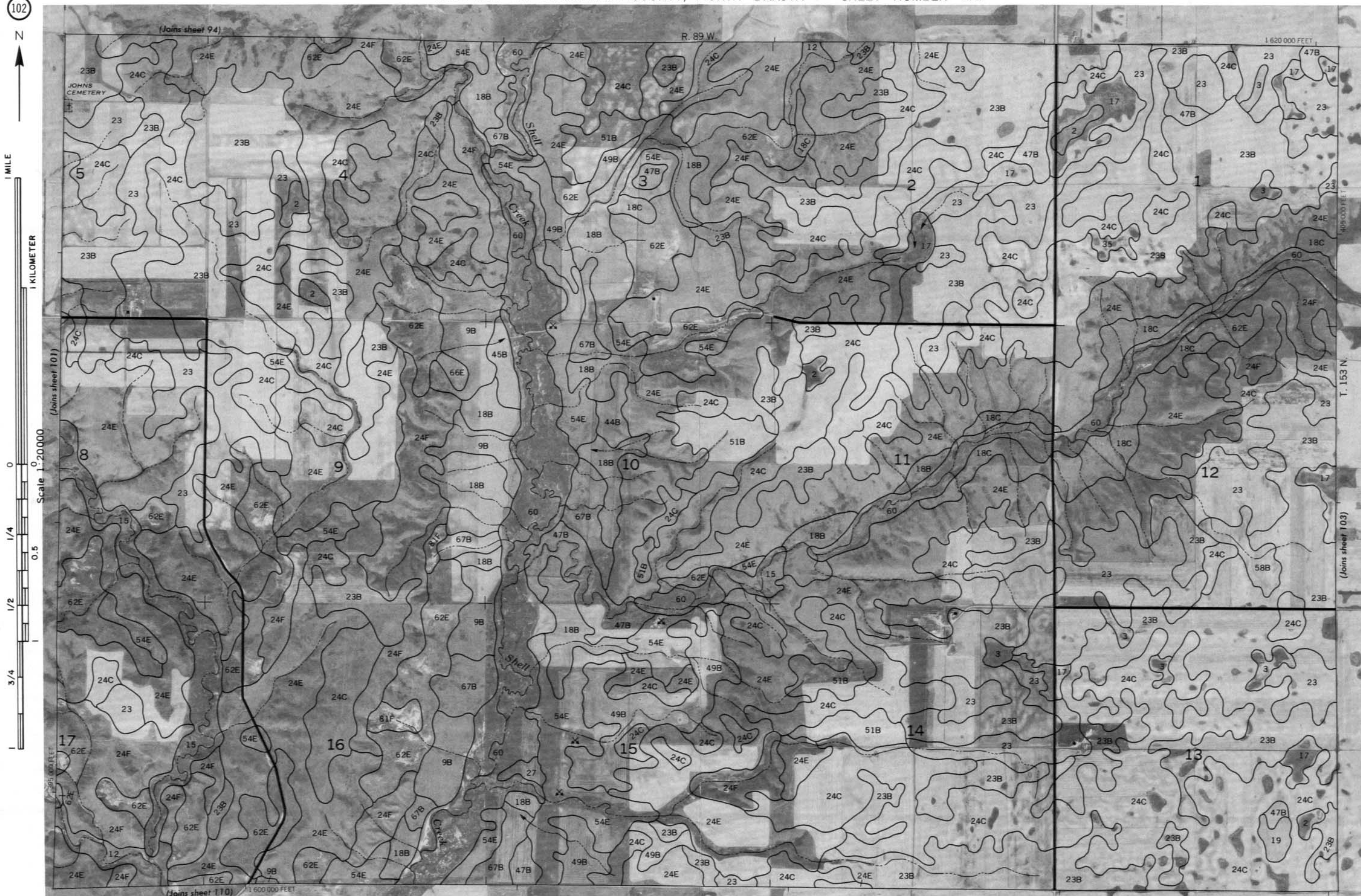


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 100

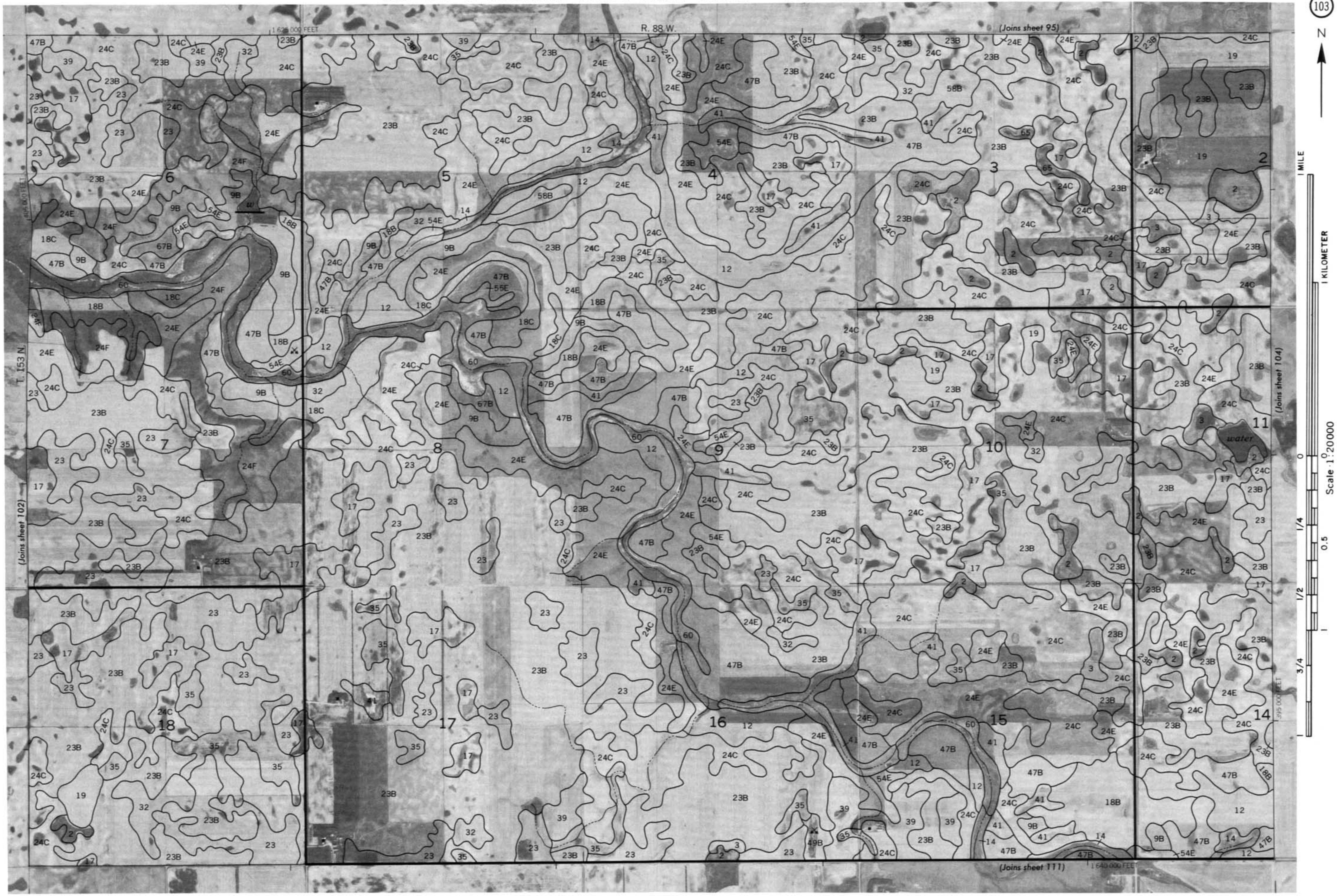


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 101

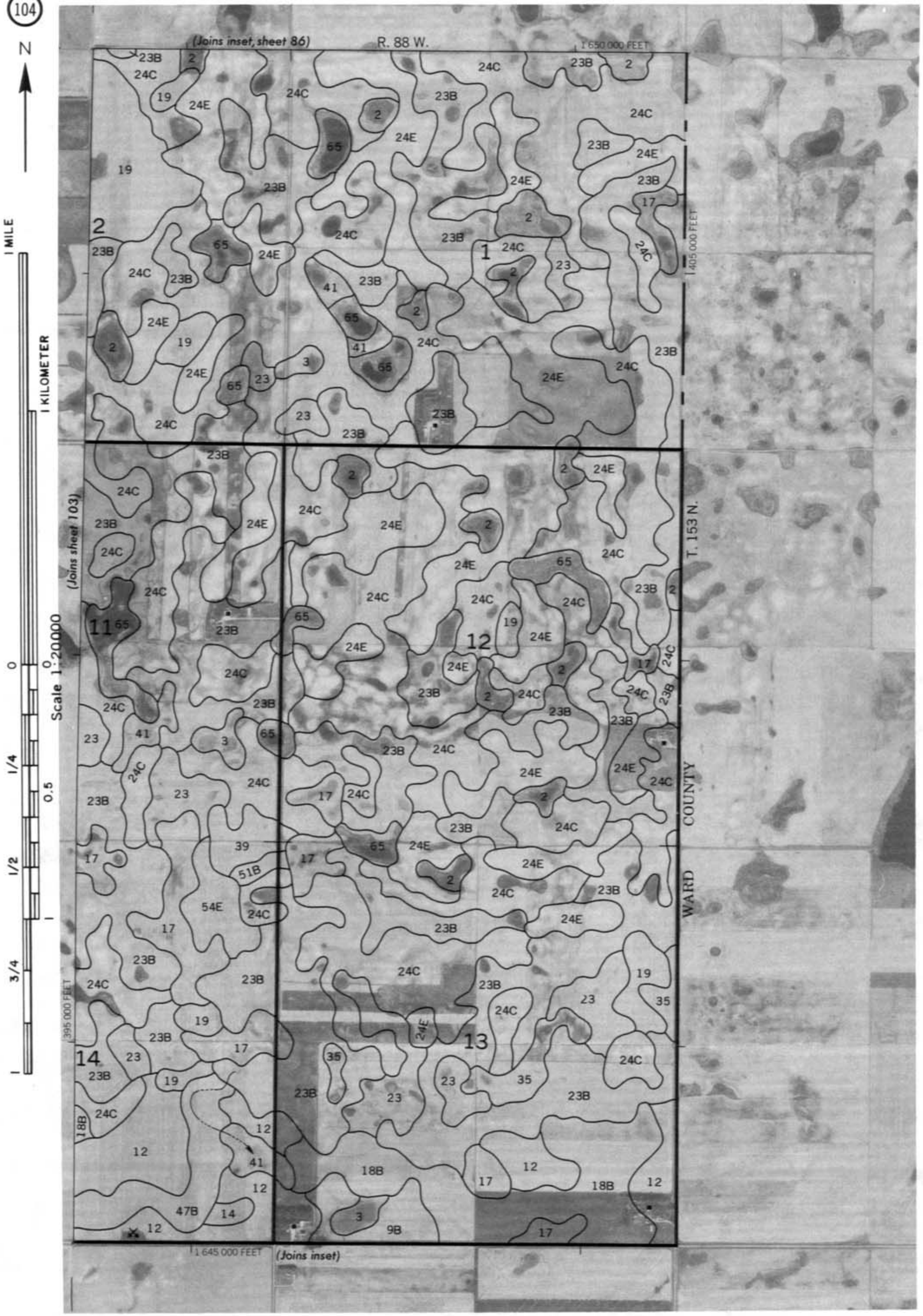


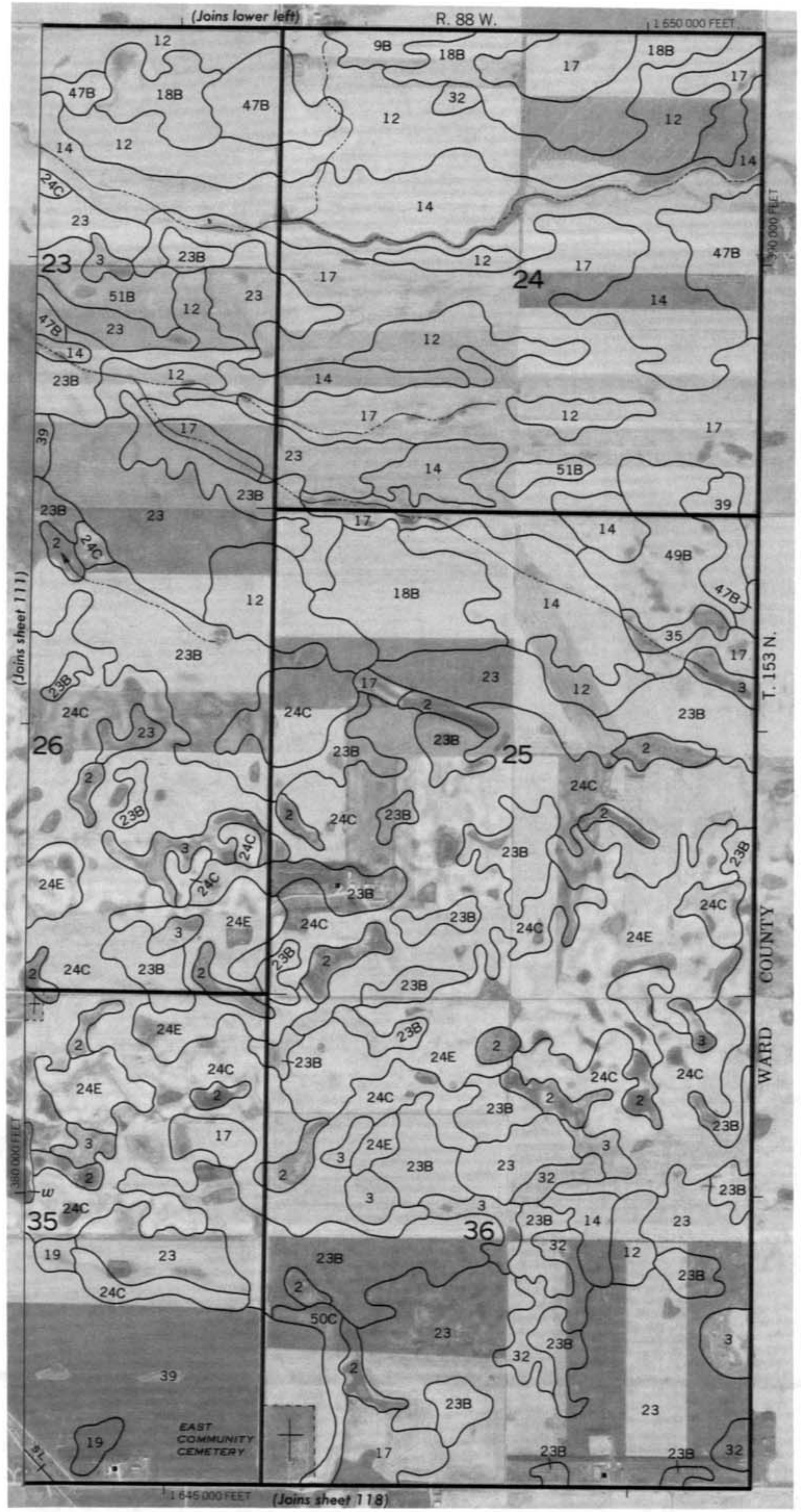

102
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 94)
R. 89 W.
1 620 000 FEET
JOHNS CEMETERY
Shell
Creek
T. 153 N.
(Joins sheet 101)
(Joins sheet 103)
(Joins sheet 110)
1 600 000 FEET

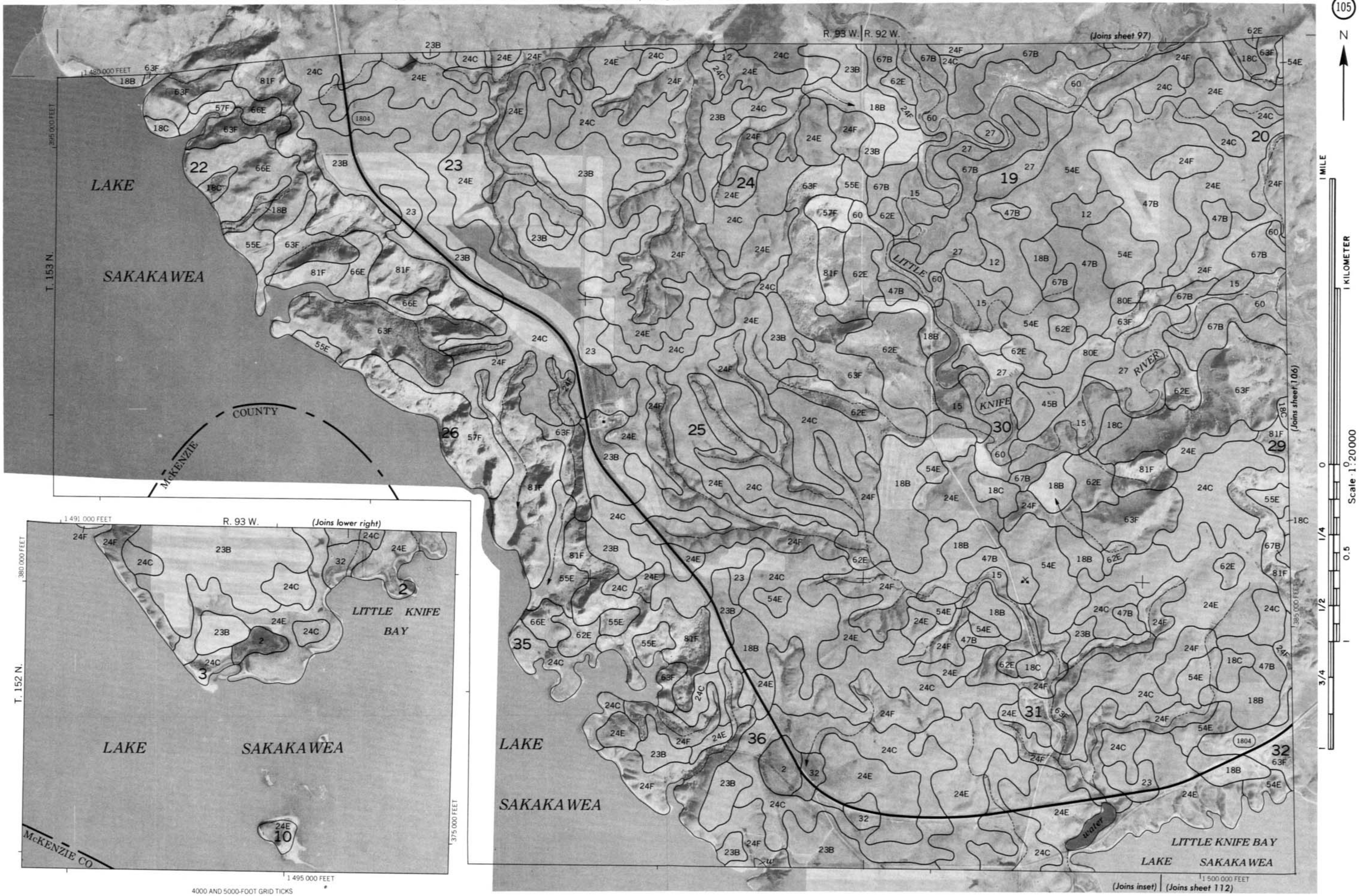
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 103



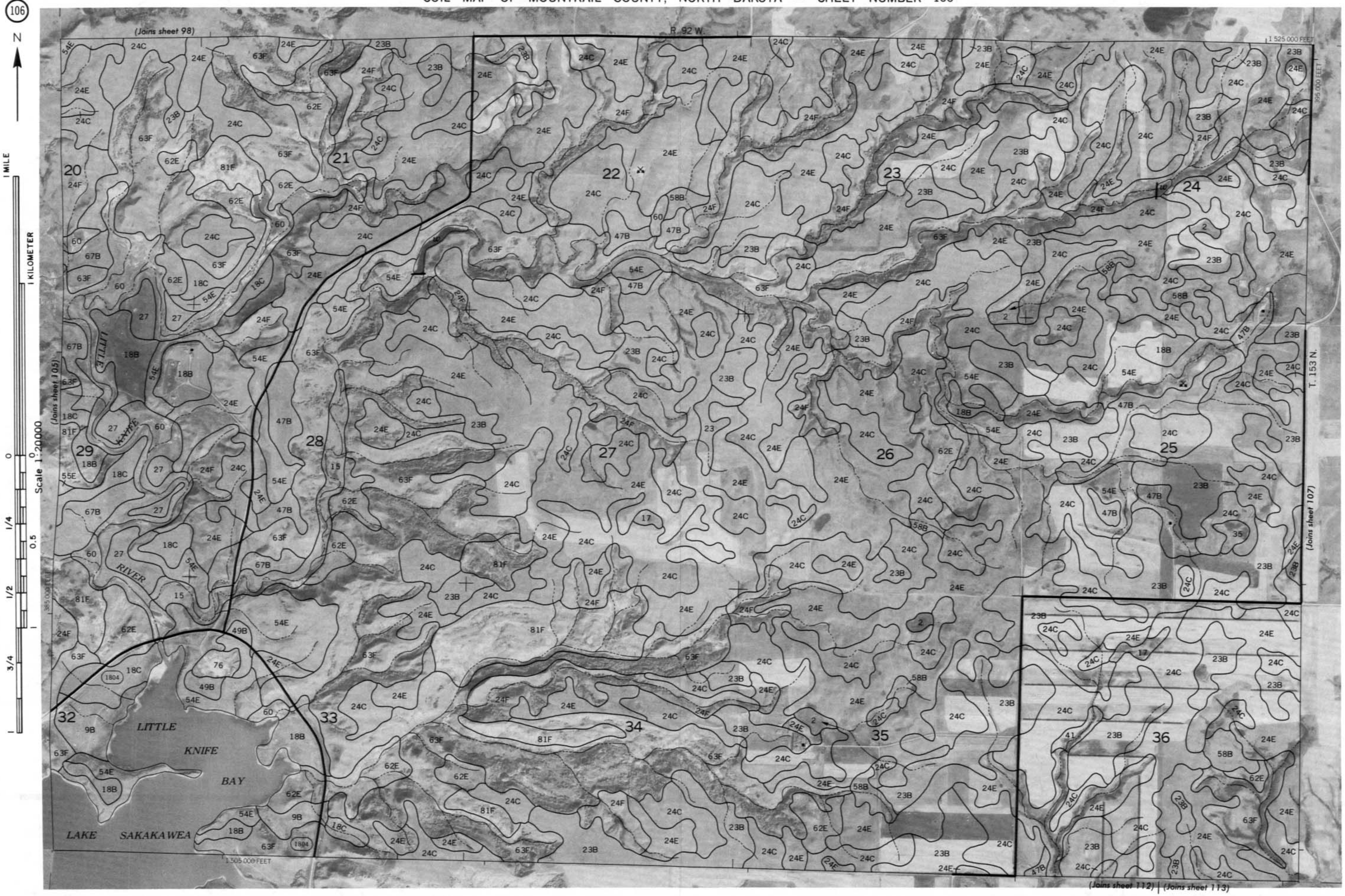
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 104

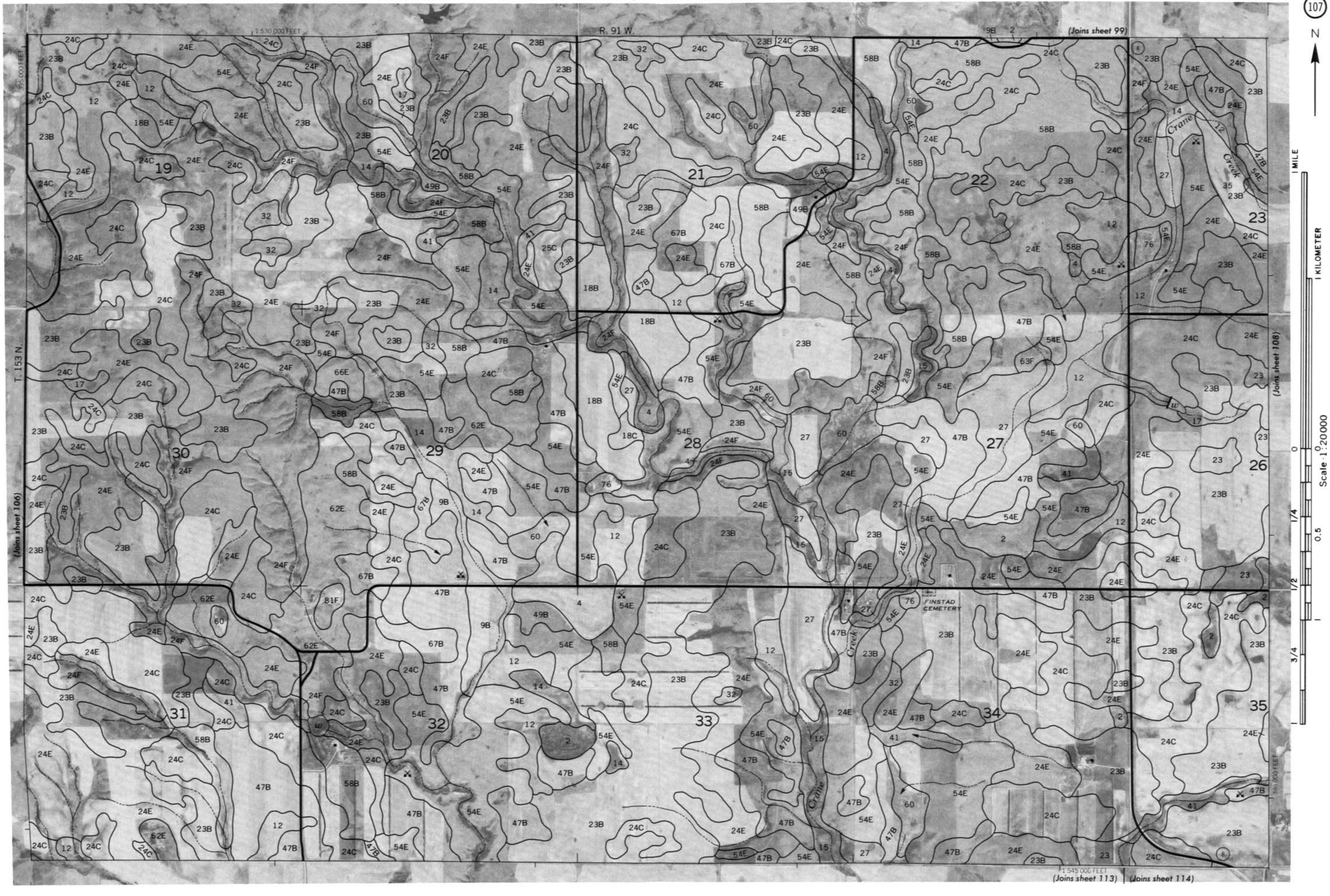




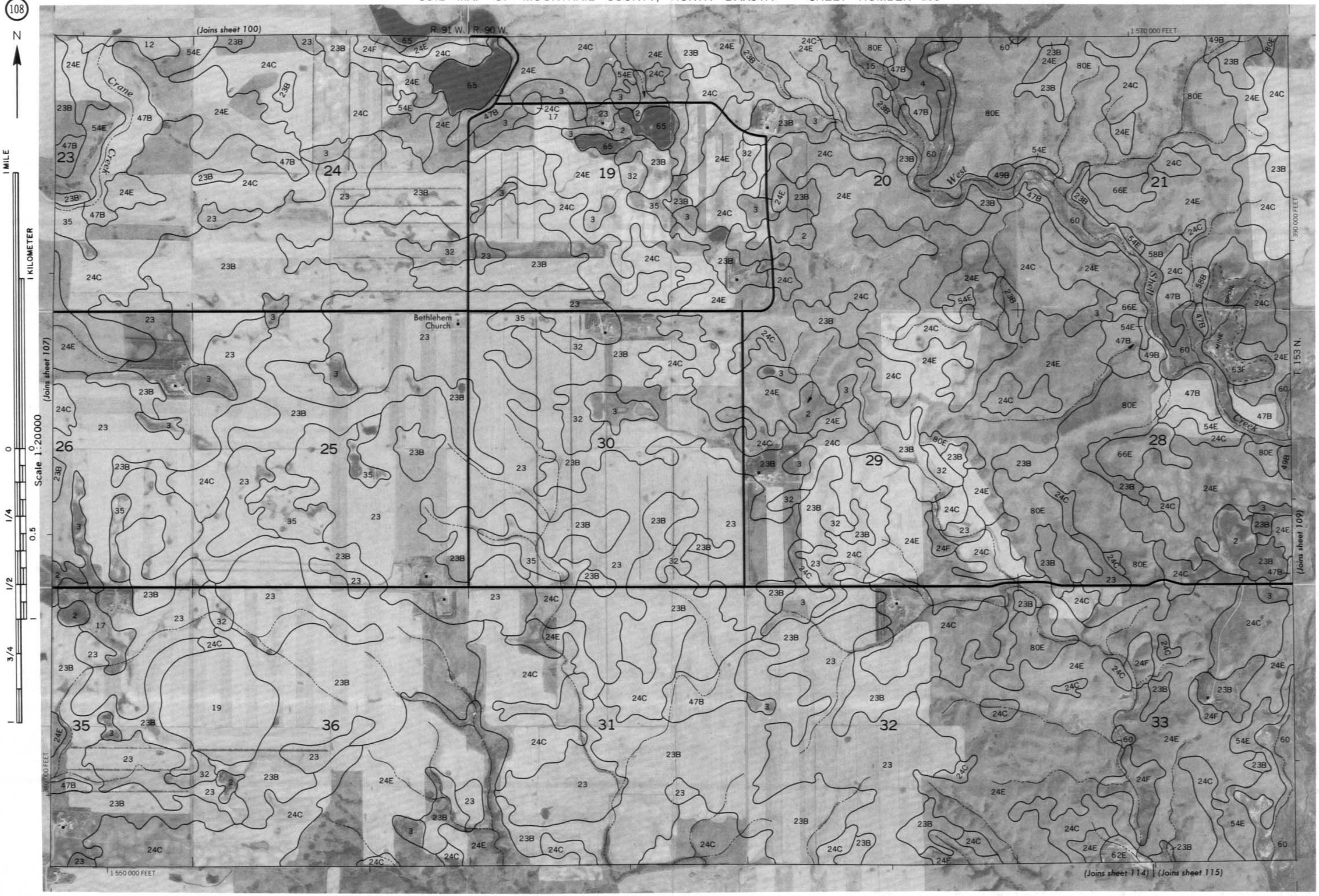

105
N
R. 93 W. | R. 92 W.
(Joins sheet 97)
(Joins sheet 106)
(Joins inset) | (Joins sheet 112)
1 480 000 FEET
295 000 FEET
385 000 FEET
1 500 000 FEET
T. 153 N.
LAKE SAKAKAWEA
LITTLE KNIFE RIVER
McKENZIE COUNTY
1804
water
LITTLE KNIFE BAY
LAKE SAKAKAWEA
1 491 000 FEET
R. 93 W.
(Joins lower right)
380 000 FEET
375 000 FEET
1 495 000 FEET
T. 152 N.
LITTLE KNIFE BAY
LAKE SAKAKAWEA
McKENZIE CO
4000 AND 5000-FOOT GRID TICKS
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 106

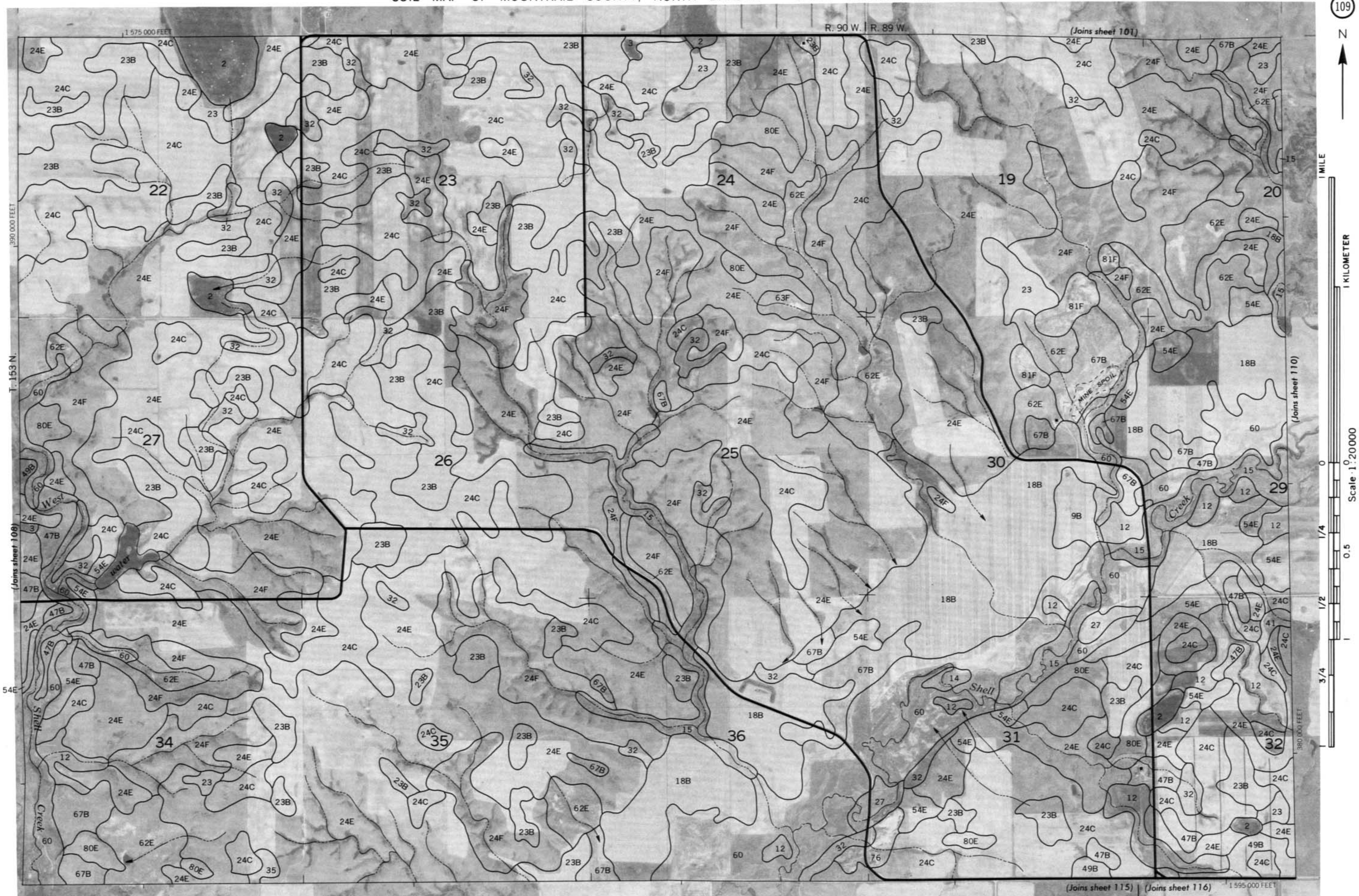



107
N
R. 91 W.
T. 153 N.
(Joins sheet 99)
(Joins sheet 106)
(Joins sheet 108)
(Joins sheet 113)
(Joins sheet 114)
1 530 000 FEET
1 545 000 FEET
Crane Creek
FINSTAD CEMETERY
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER
Scale 1:20000

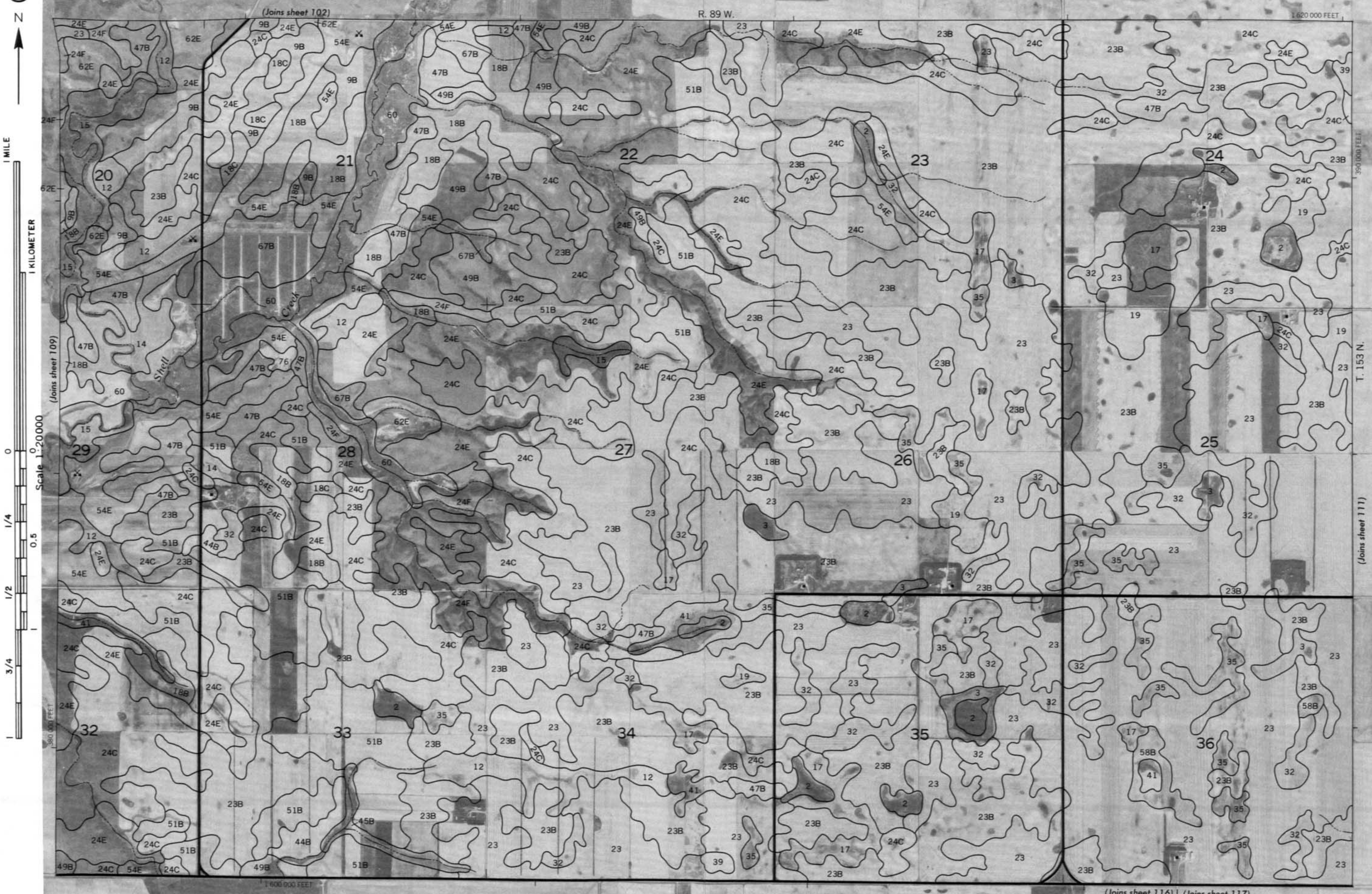
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 108

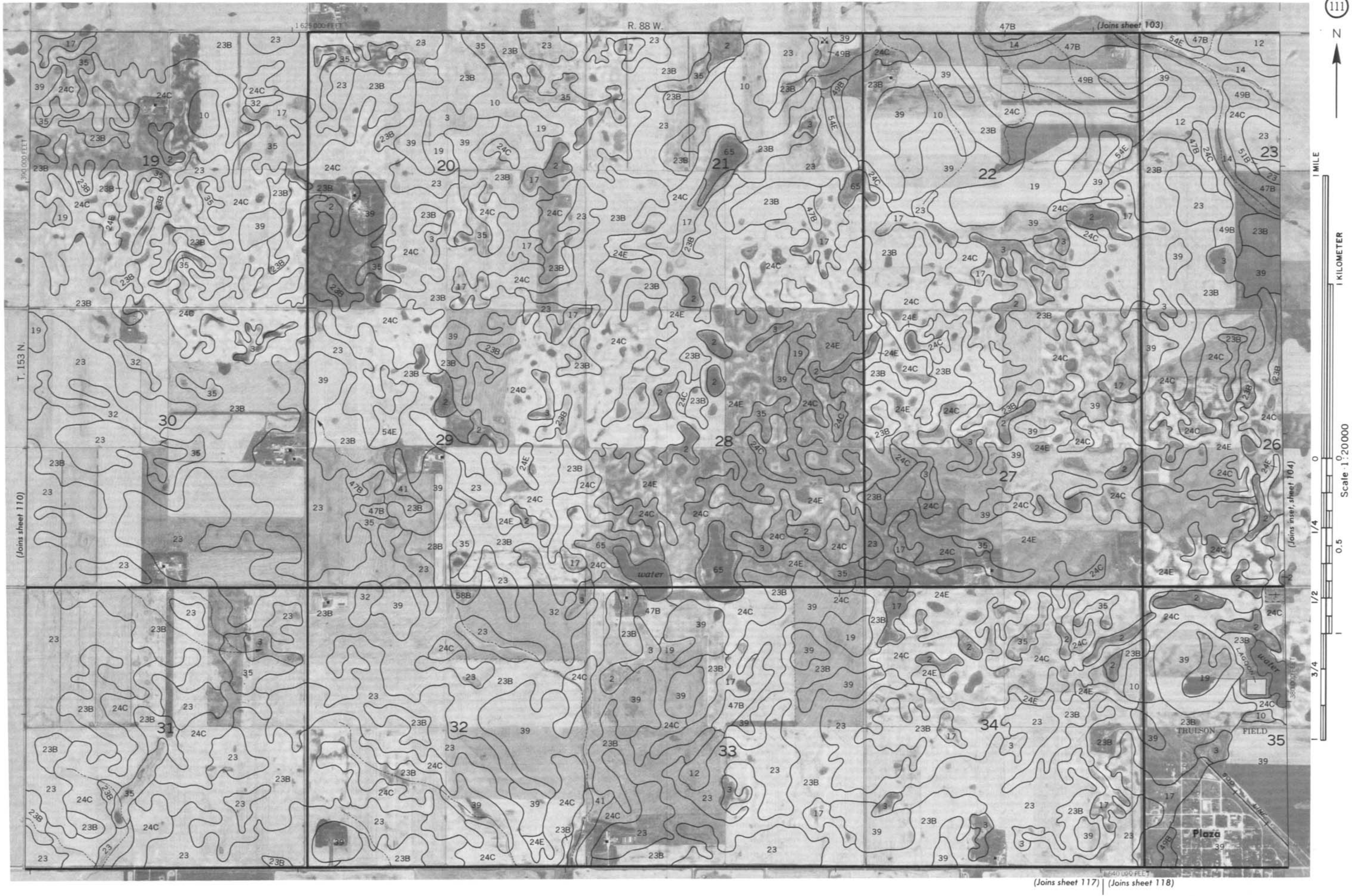


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 109

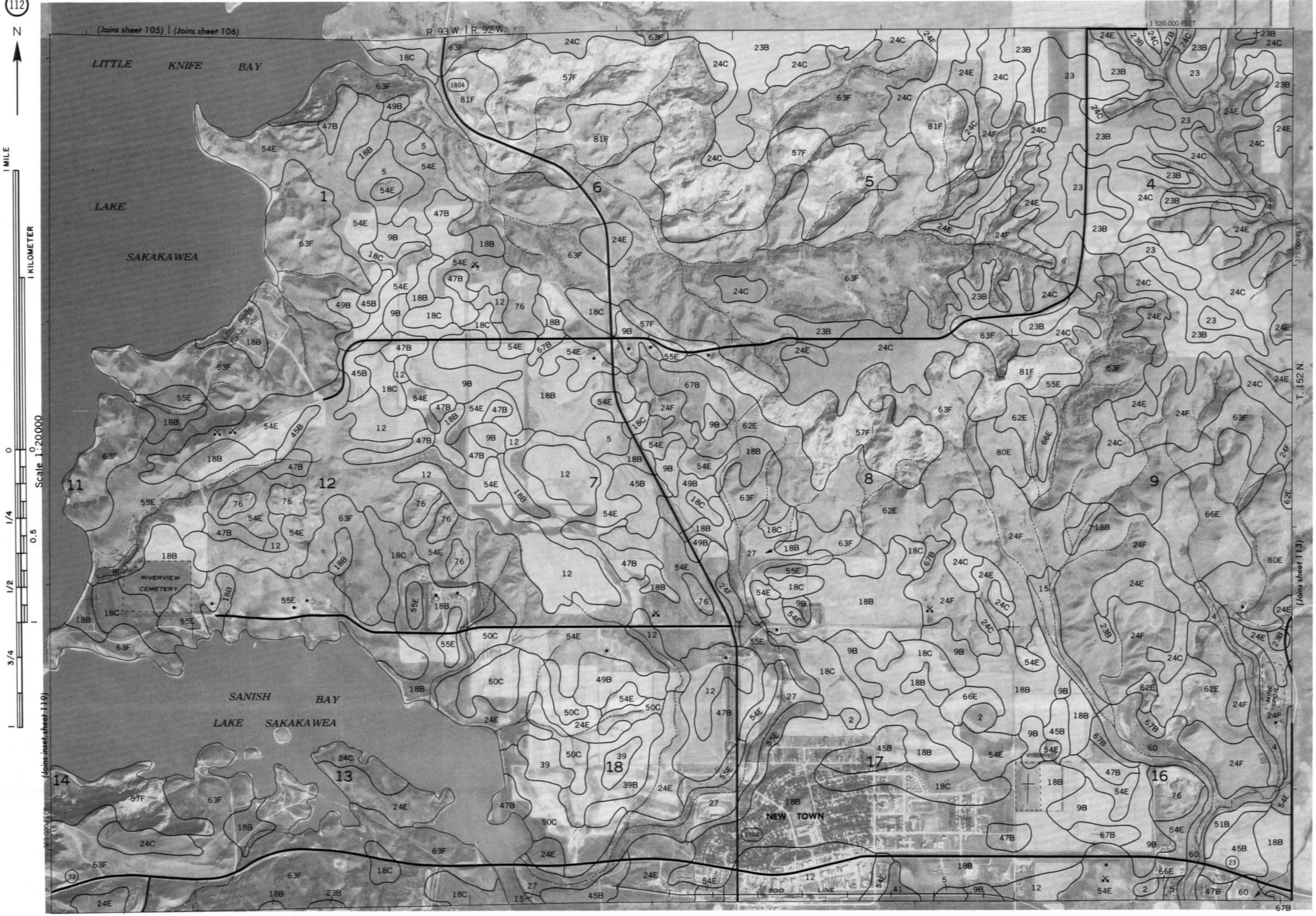


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 110

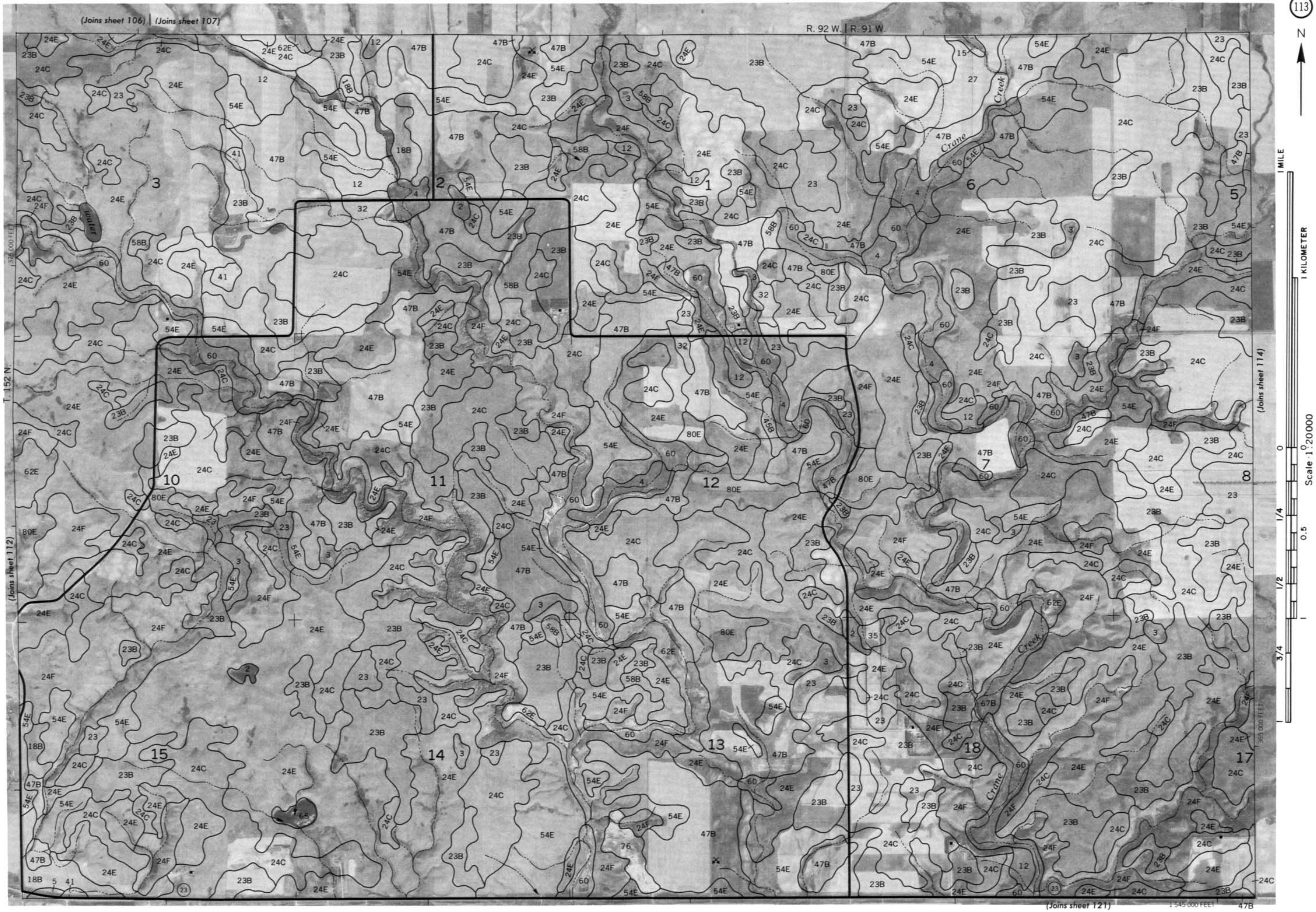



111
N
R. 88 W.
T. 153 N.
(Joins sheet 103)
(Joins sheet 110)
(Joins inset, sheet 104)
(Joins sheet 117)
(Joins sheet 118)
1 625 000 FEET
390 000 FEET
1 640 000 FEET
380 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
LAGOON
TRULSON
FIELD
Plaza
SOO LINE
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20 000

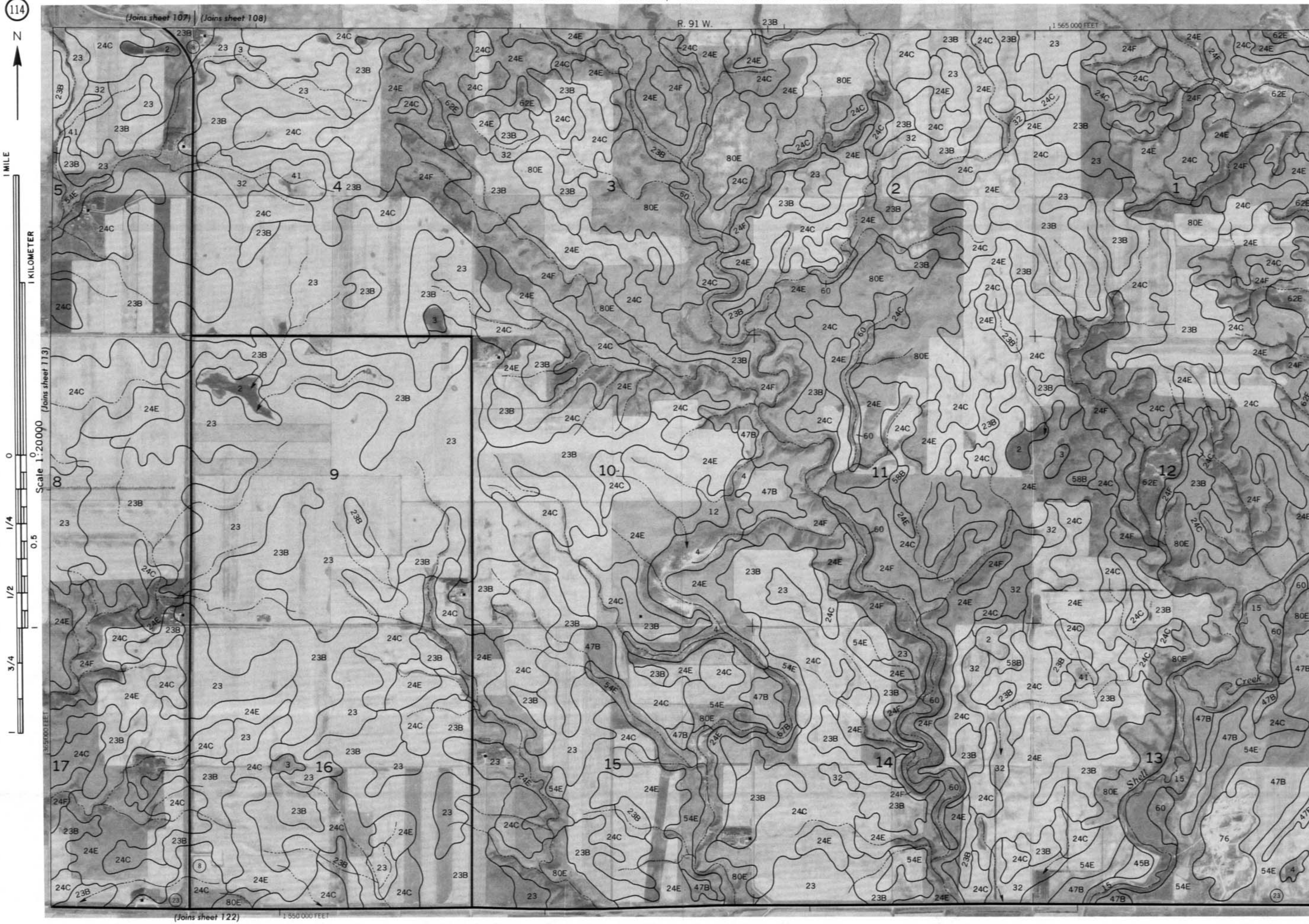
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 112



SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 113

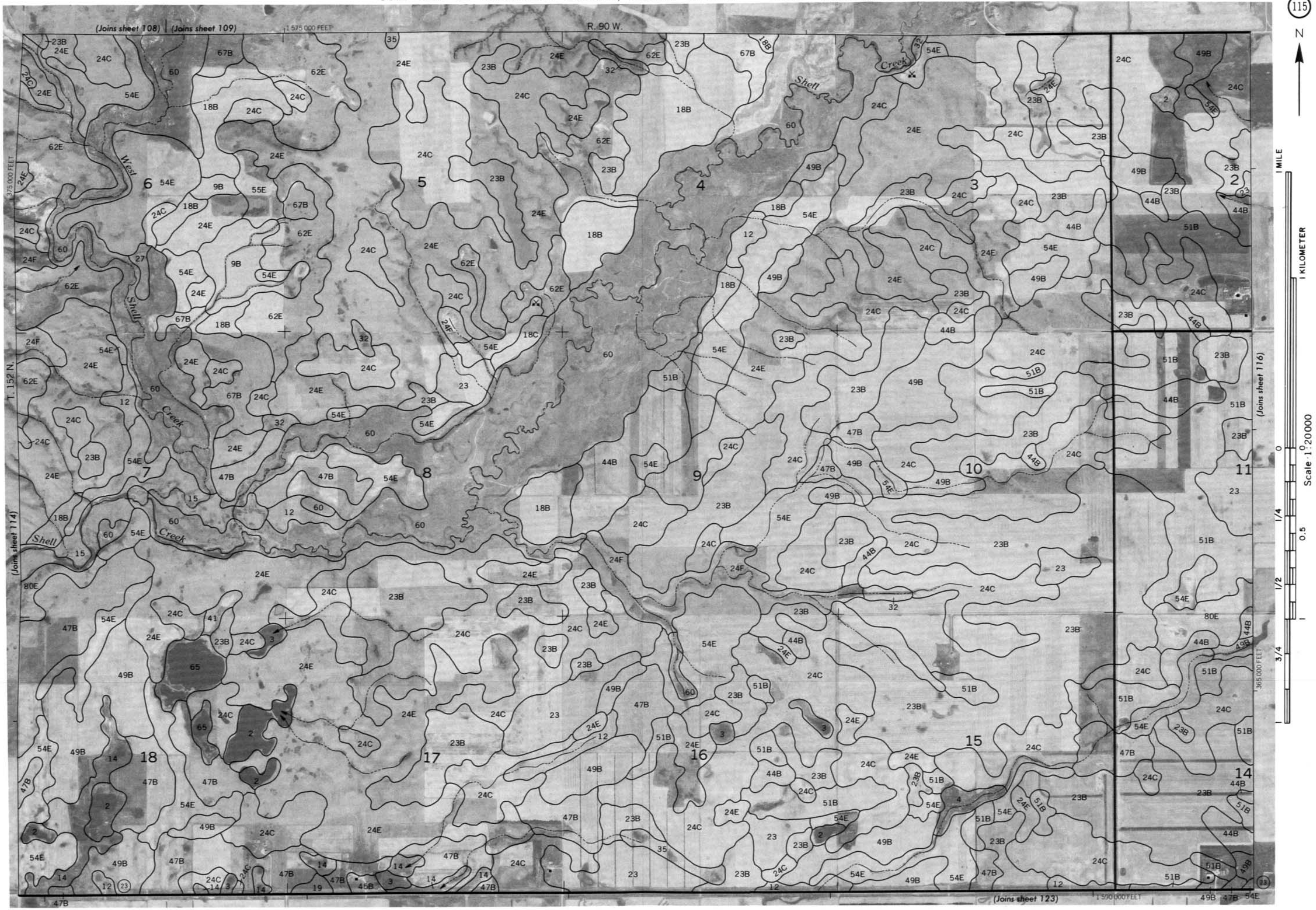


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 114

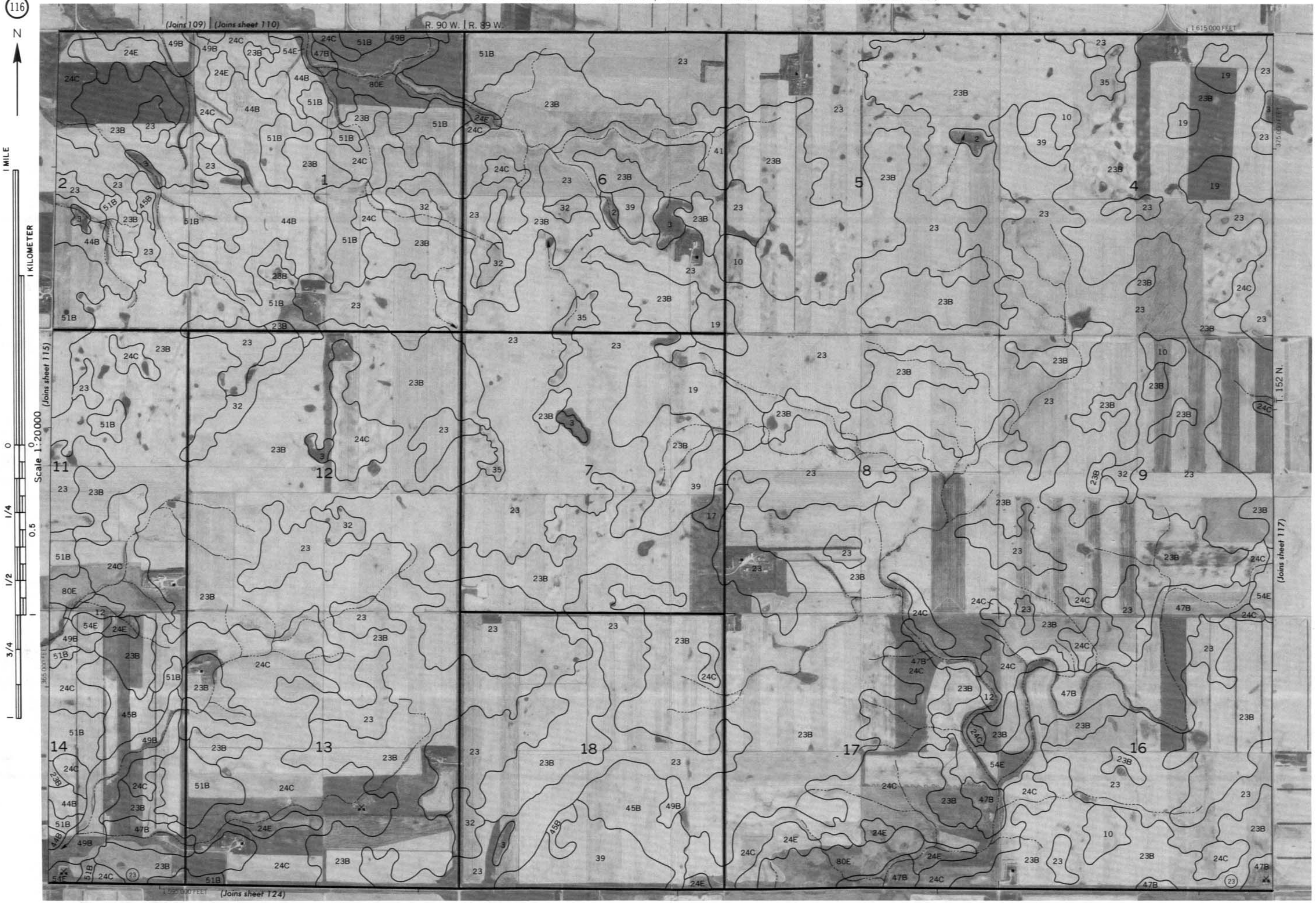


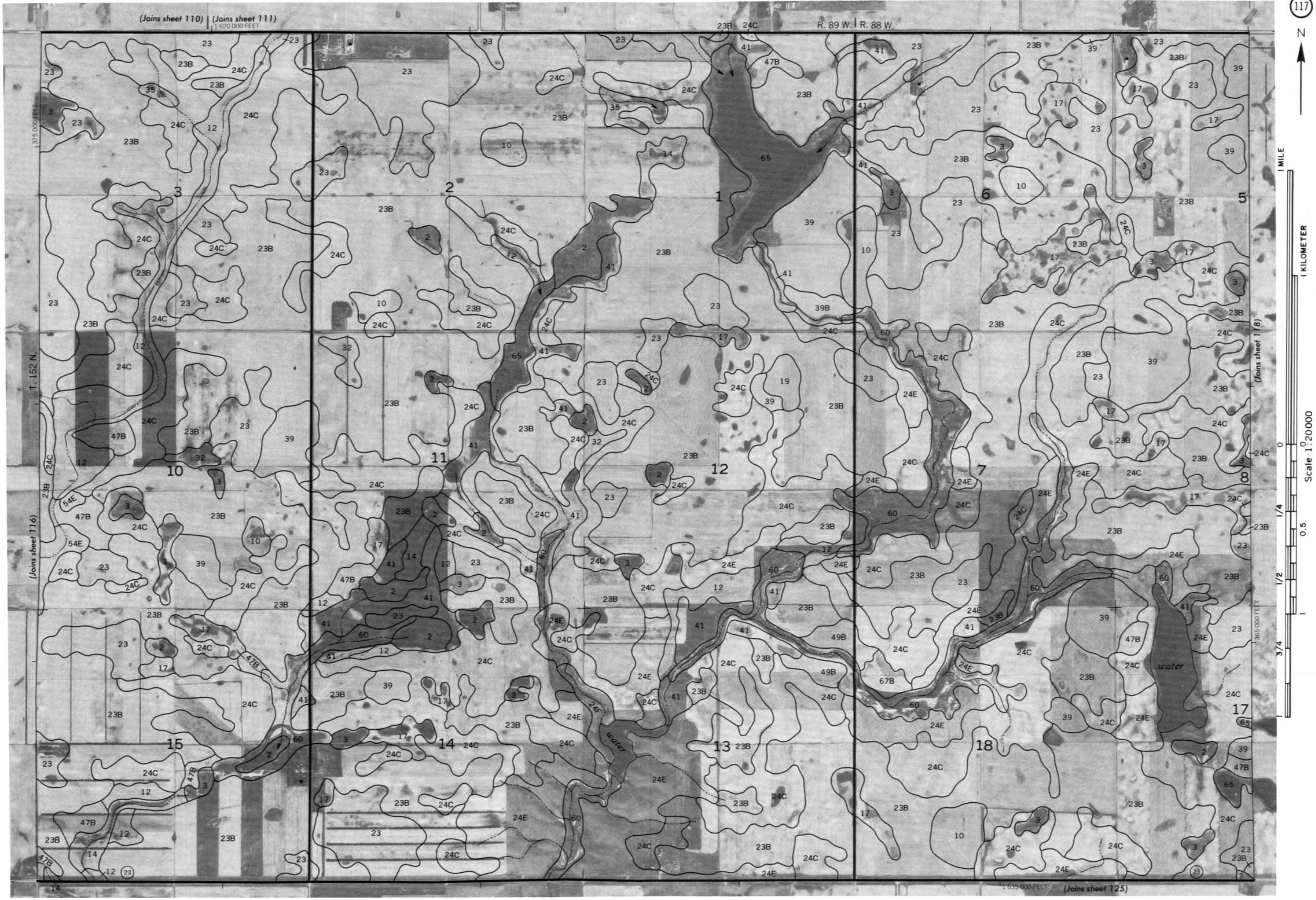
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 115

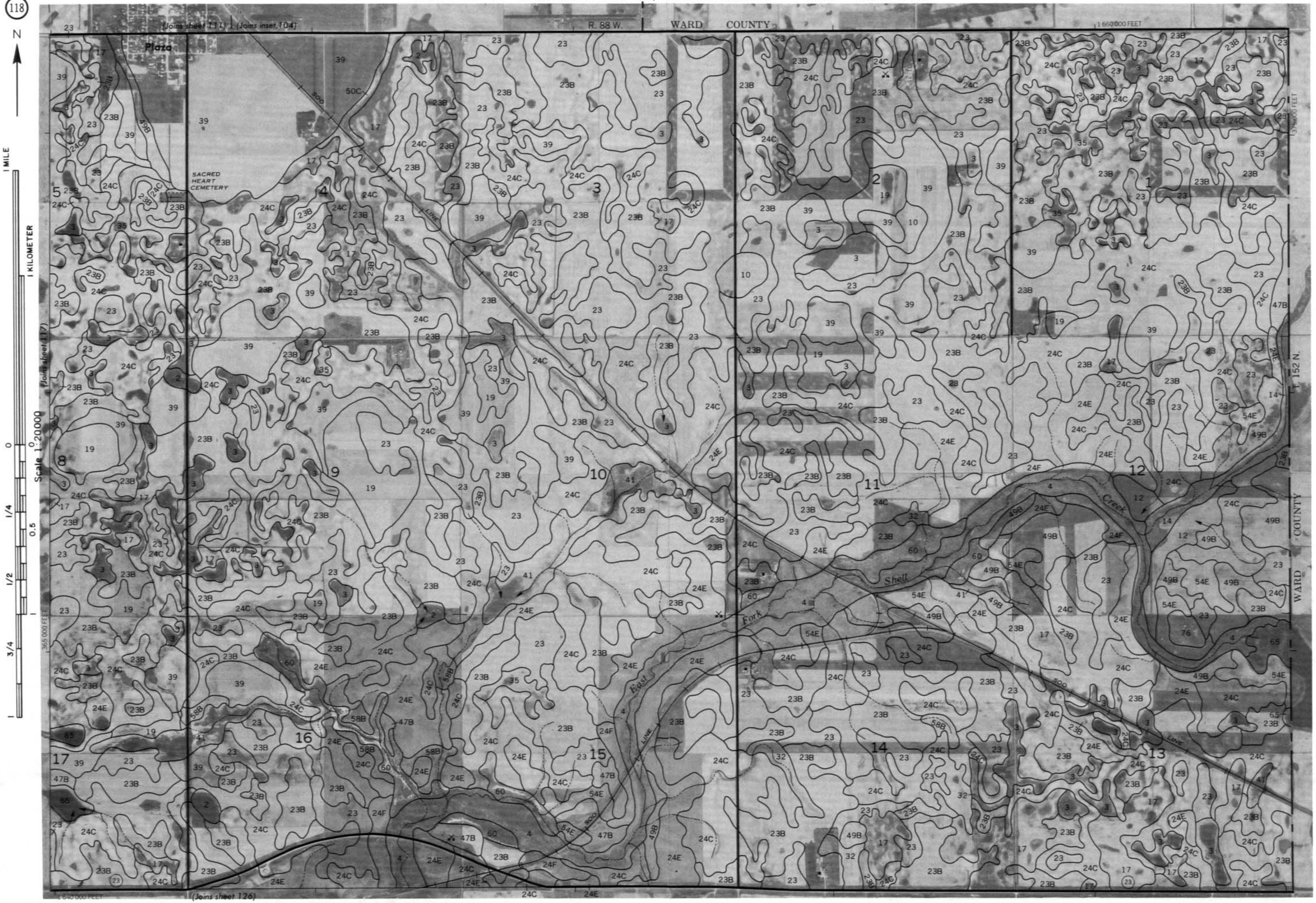
115



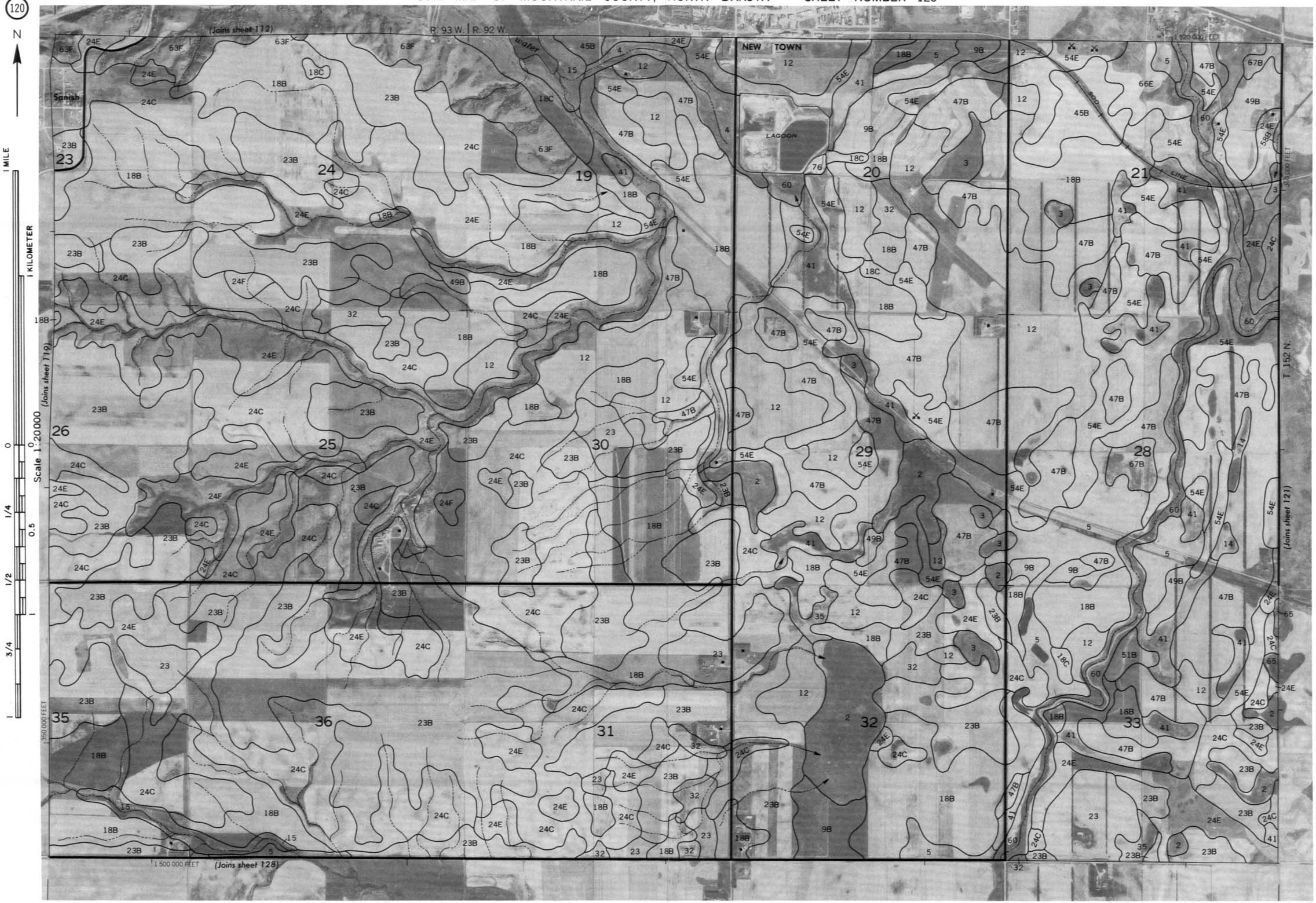
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 116

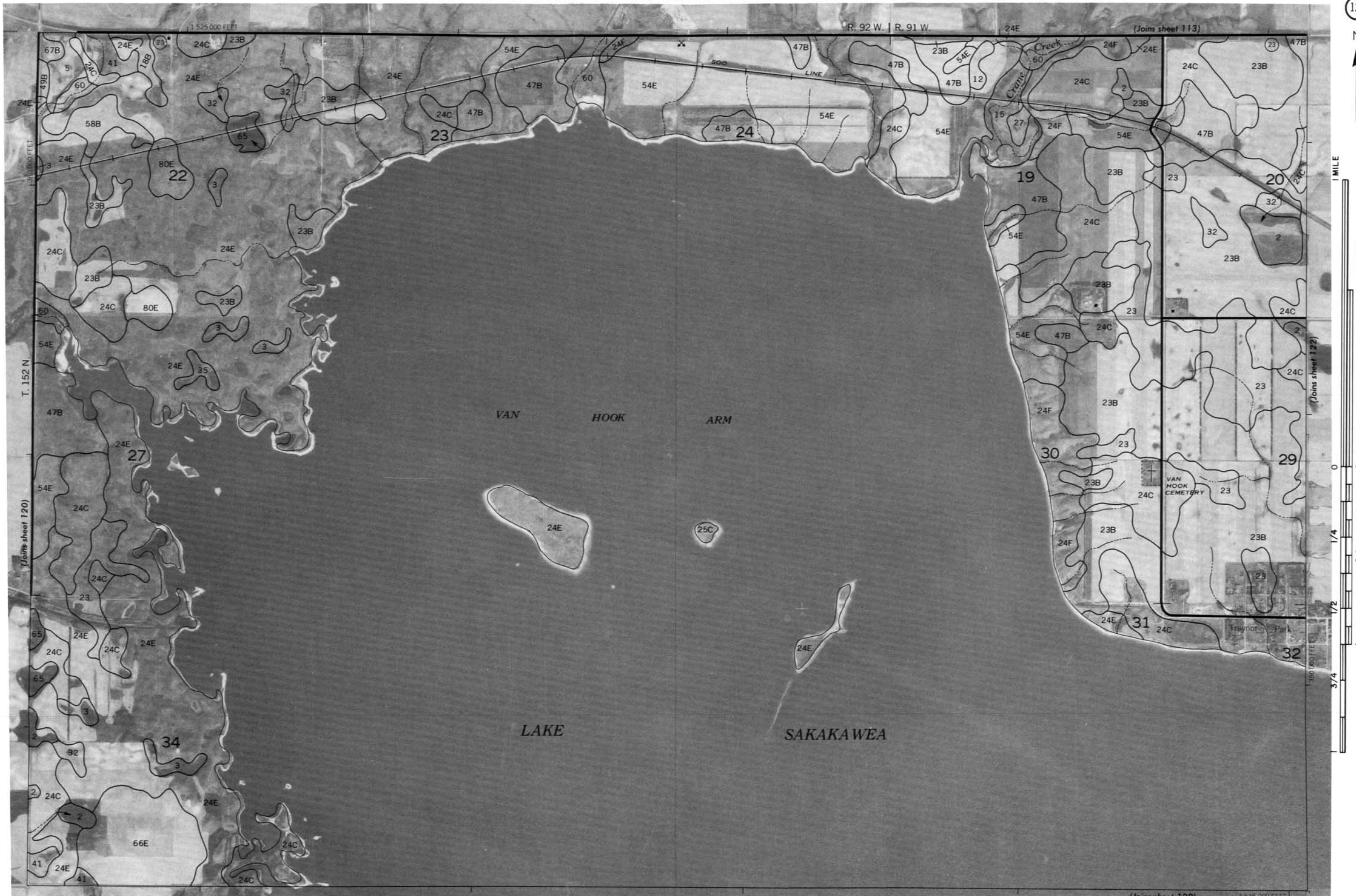



117
N
(Joins sheet 110)
(Joins sheet 111)
1 620 000 FEET
R. 89 W.
R. 88 W.
T. 152 N.
375 000 FEET
365 000 FEET
1 635 000 FEET
(Joins sheet 116)
(Joins sheet 118)
(Joins sheet 125)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
water

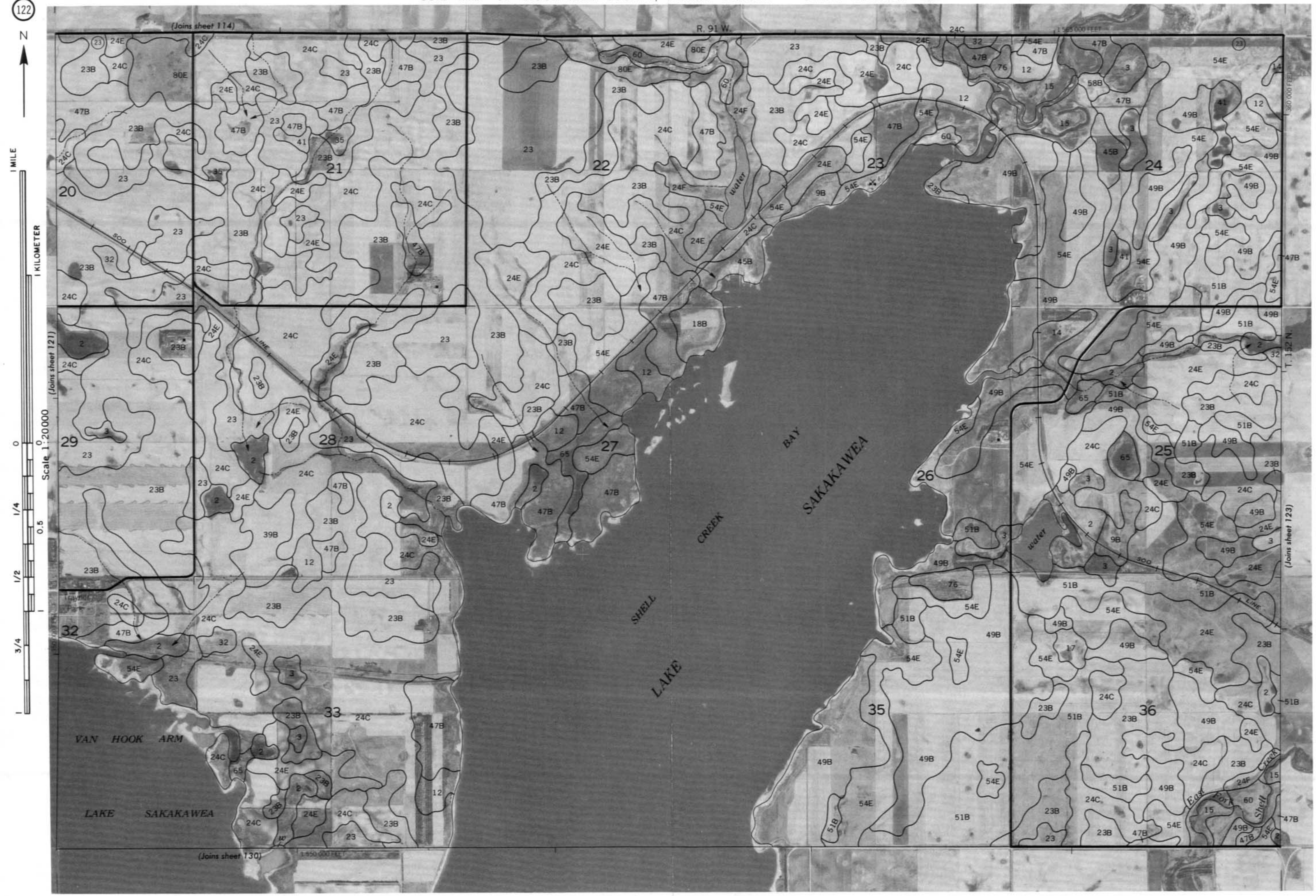

118
N
1 MILE
1 KILOMETER
Scale 1:20000
Plaza
SACRED HEART CEMETERY
(Joins sheet 111)
(Joins inset 104)
(Joins sheet 117)
(Joins sheet 126)
R. 88 W.
WARD COUNTY
T. 152 N.
1 660 000 FEET
1 640 000 FEET
365 000 FEET
East Fork Shell Creek
SOO LINE

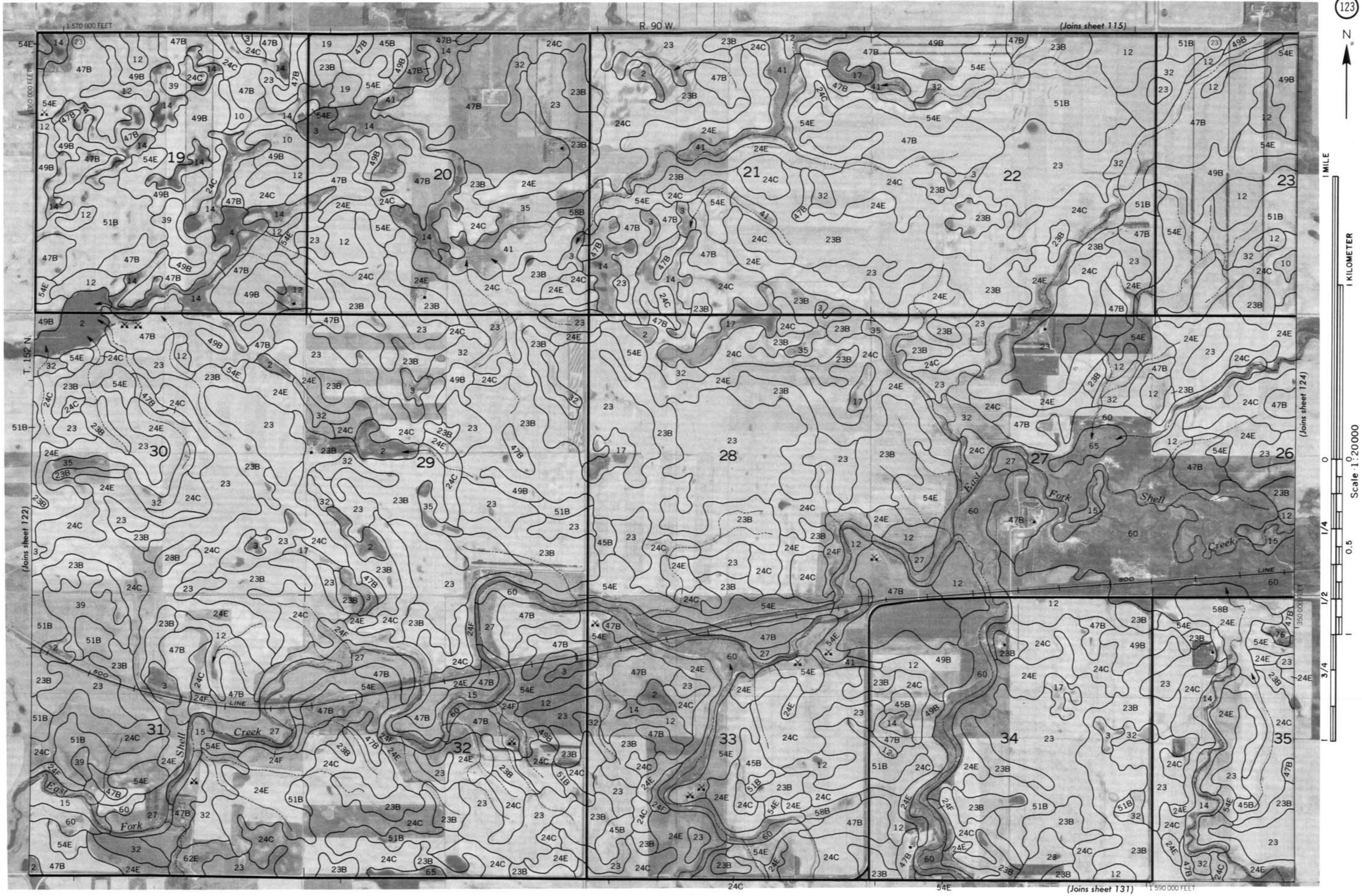

119
N
R. 93 W.
T. 152 N.
(Joins inset)
Sanish
LAKE
SAKAKAWEA
McKENZIE
COUNTY
(Joins sheet 120)
(Joins sheet 127)
(Joins sheet 112)
(Joins upper right)
1 475 000 FEET
1 497 000 FEET
1 495 000 FEET
360 000 FEET
370 000 FEET
350 000 FEET
1000 AND 5000-FOOT GRID TICKS
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
14
23
26
27
28
32
33
34
35
3
18B
23B
24C
24E
24F
32
49B
55E
57F
63F
81F


120
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 112)
(Joins sheet 119)
(Joins sheet 121)
(Joins sheet 128)
R. 93 W. | R. 92 W.
T. 152 N.
NEW TOWN
LAGOON
Sanish
water
1 500 000 FEET
350 000 FEET
1 920 000 FEET
380 000 FEET



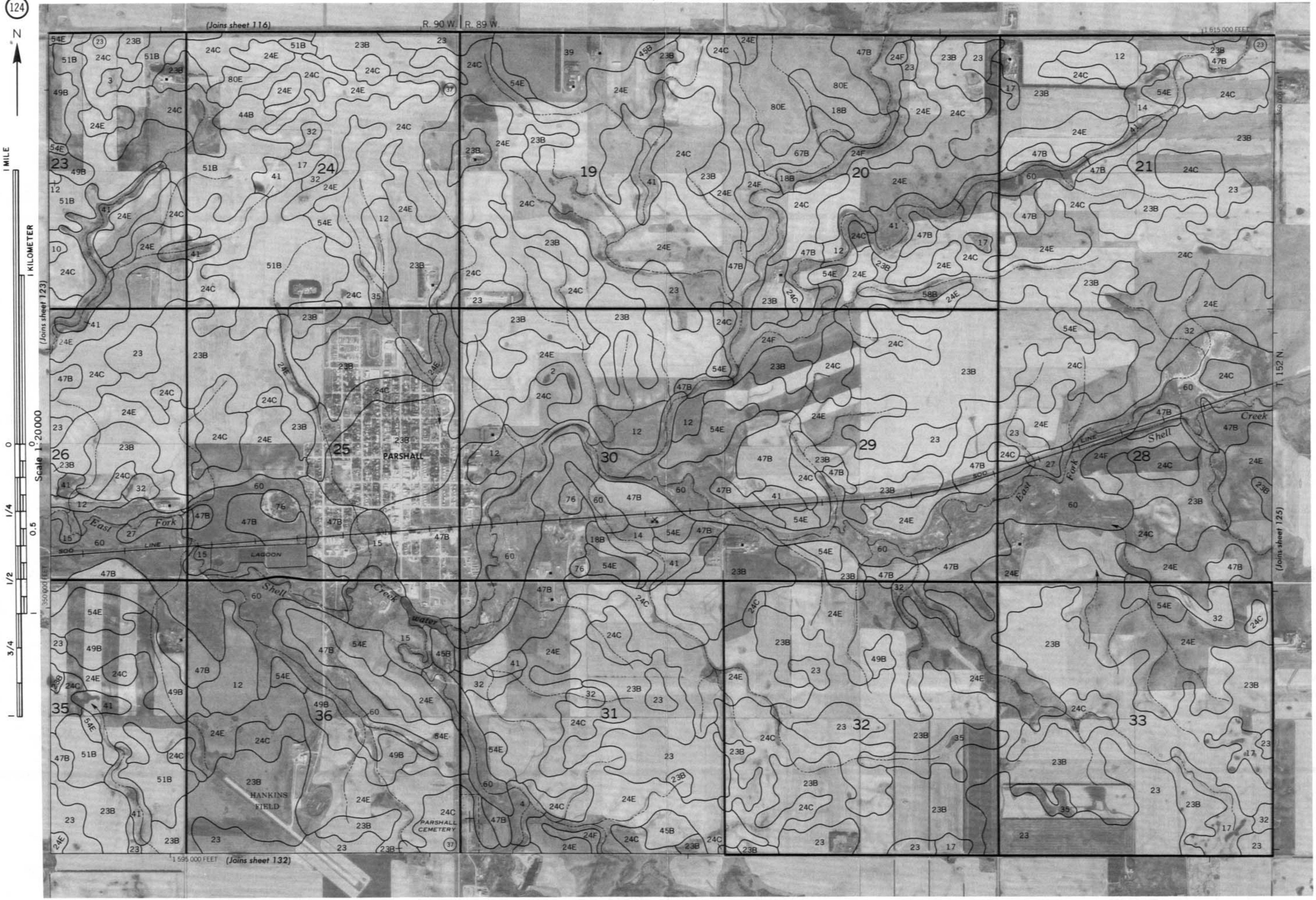
121
N
(Joins sheet 113)
(Joins sheet 120)
(Joins sheet 122)
(Joins sheet 129)
R. 92 W. | R. 91 W.
T. 152 N.
1 525 000 FEET
1 545 000 FEET
SOO LINE
Crane Creek
VAN HOOK ARM
LAKE SAKAKAWEA
VAN HOOK CEMETERY
Traynor Park
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1


122
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 114)
(Joins sheet 121)
(Joins sheet 123)
(Joins sheet 130)
R. 91 W.
T. 152 N.
1 565 000 FEET
1 550 000 FEET
LAKE SAKAKAWEA
SHELL CREEK BAY
VAN HOOK ARM
East Fork Shell Creek
water
LINE
20
21
22
23
24
25
26
27
28
29
32
33
35
36

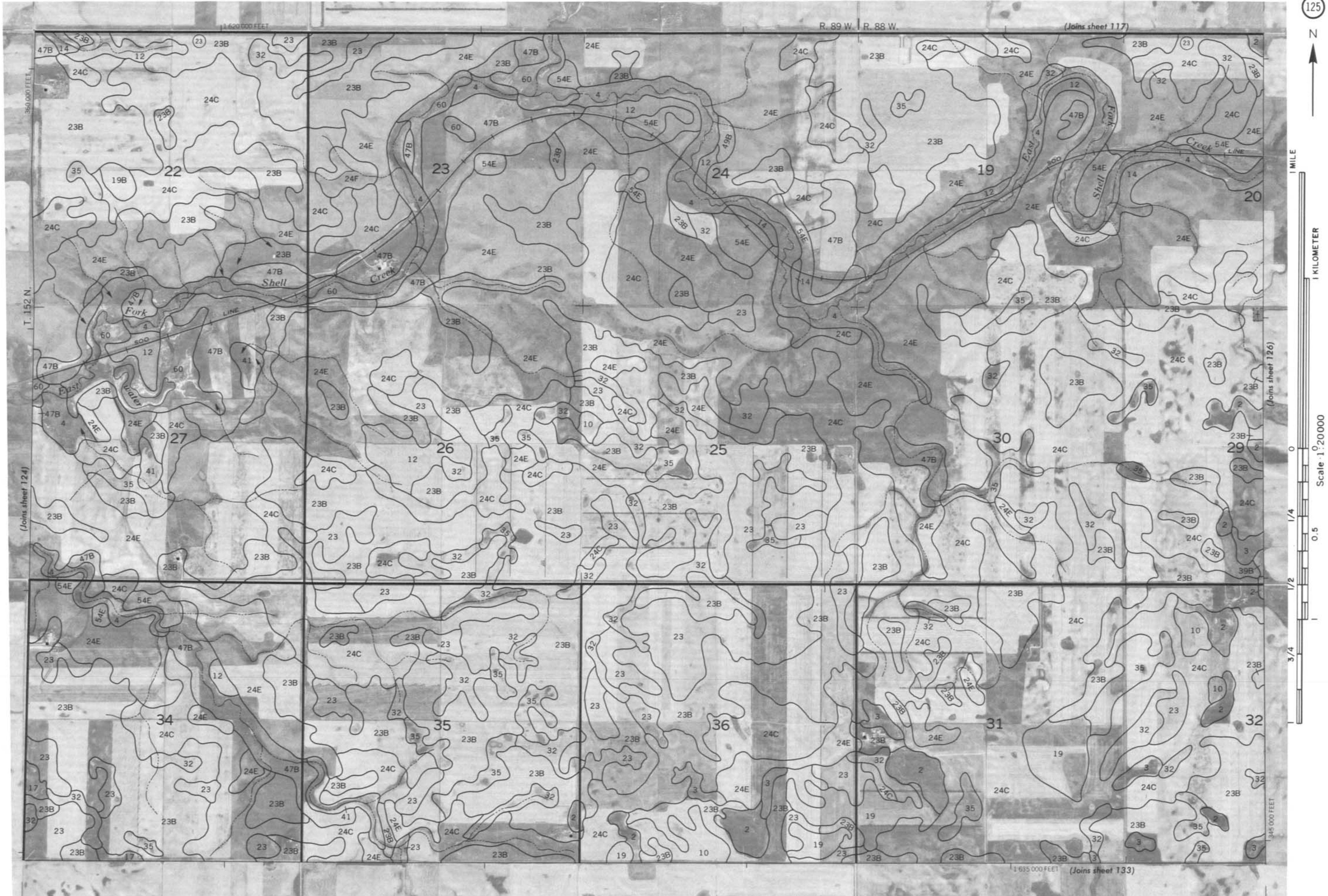


1 570 000 FEET
R. 90 W.
(Joins sheet 115)
N
T. 152 N.
(Joins sheet 122)
(Joins sheet 124)
(Joins sheet 131)
350 000 FEET
1 590 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
East Fork Shell Creek
SOO LINE
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 124

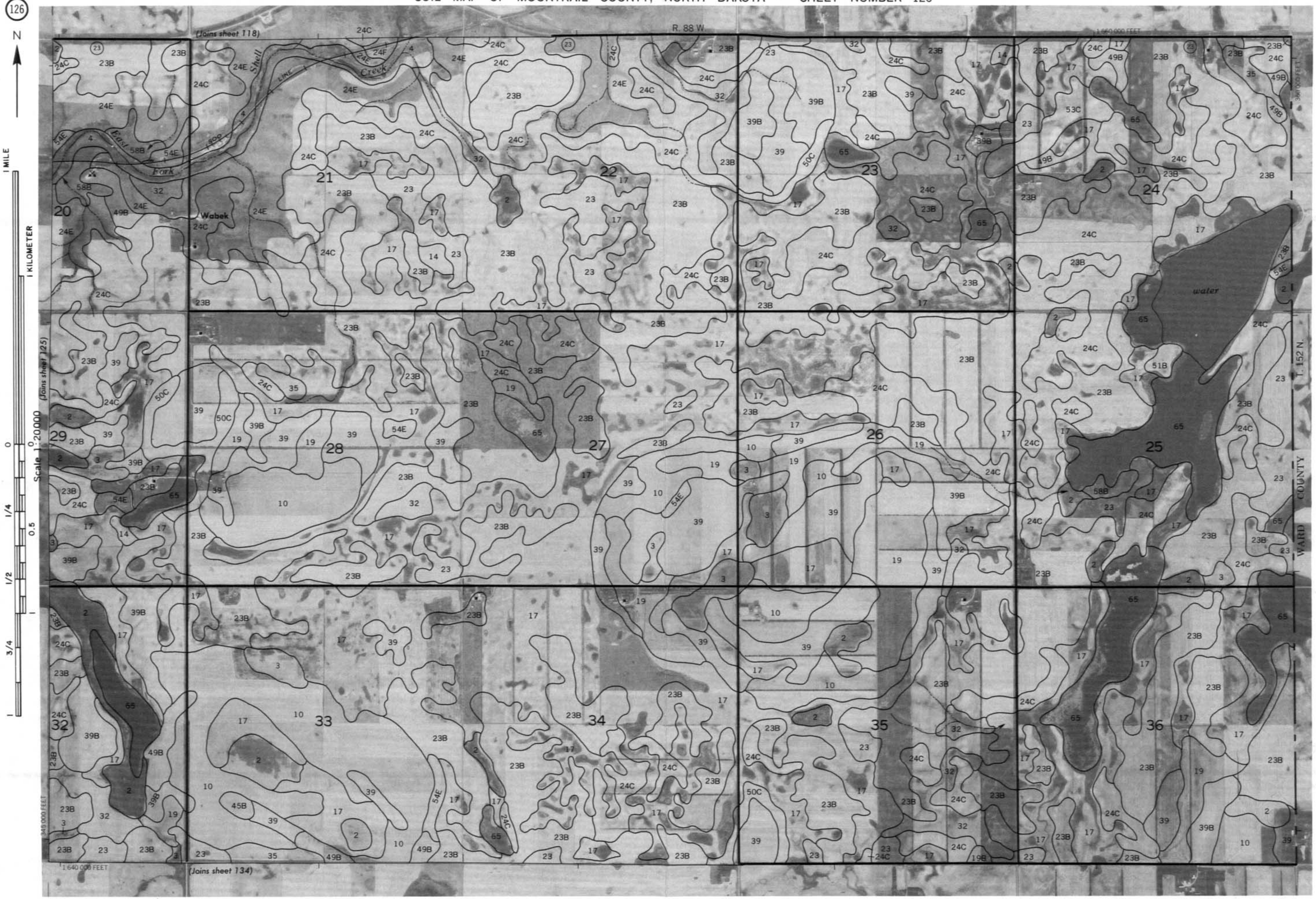


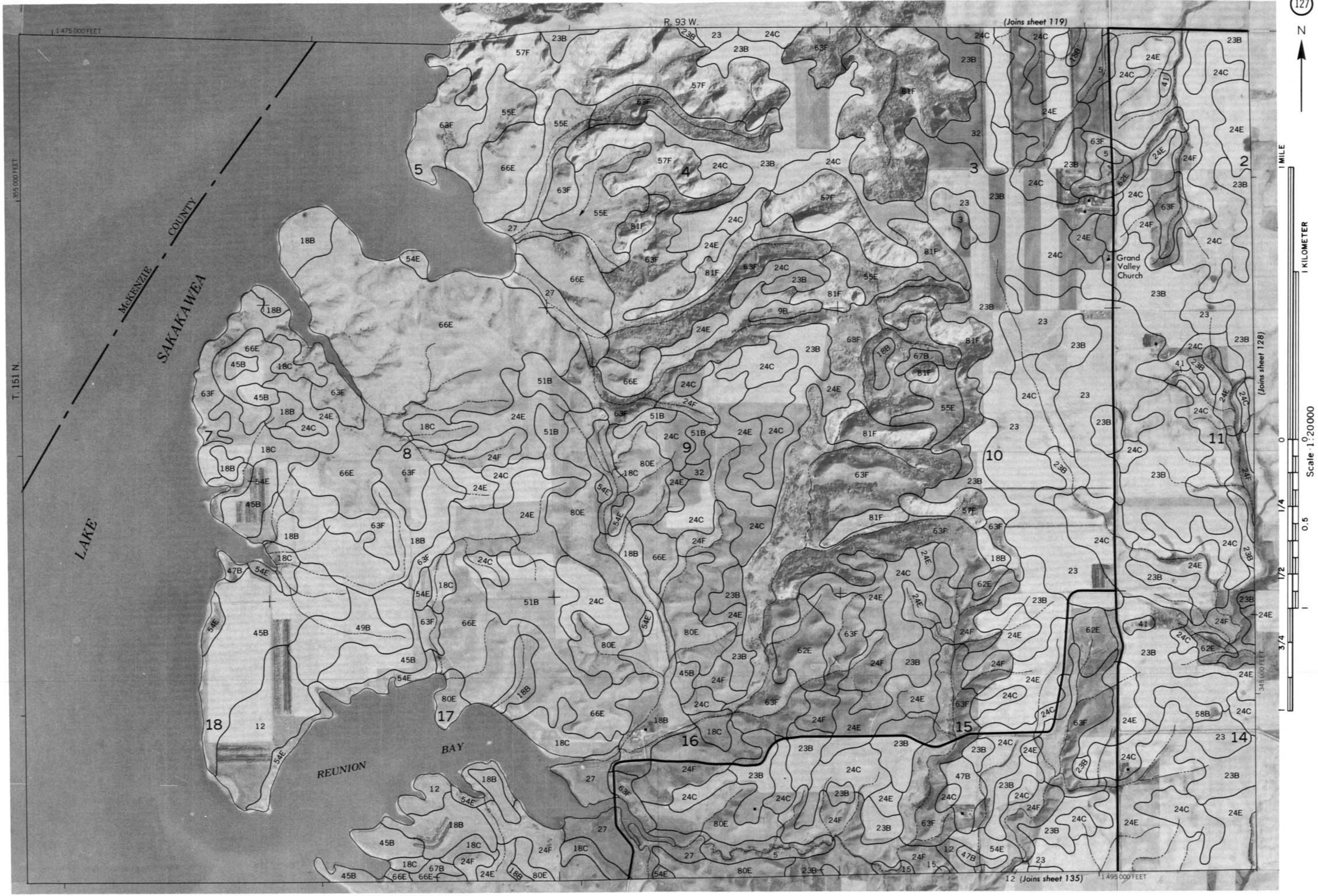
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 125



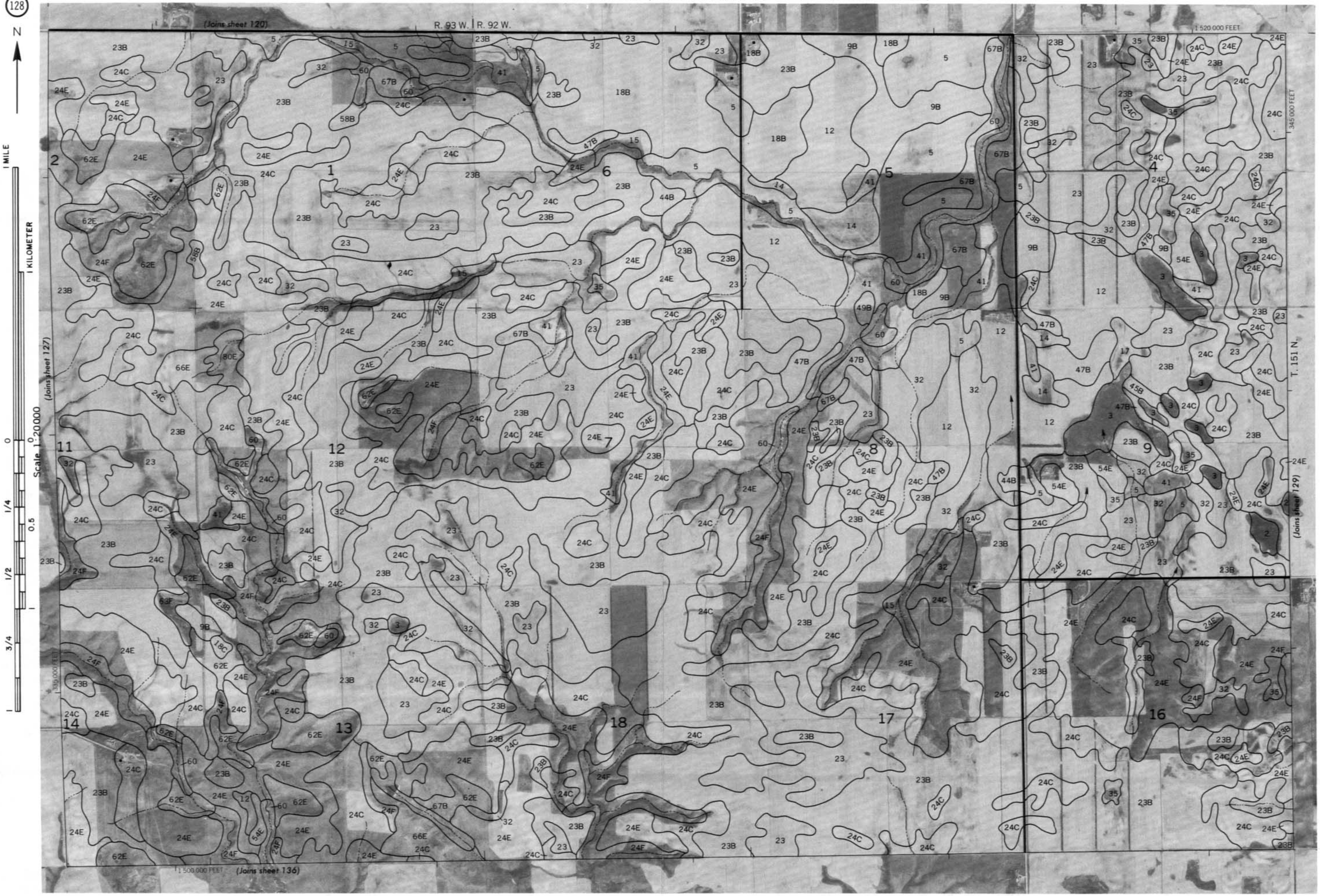
126

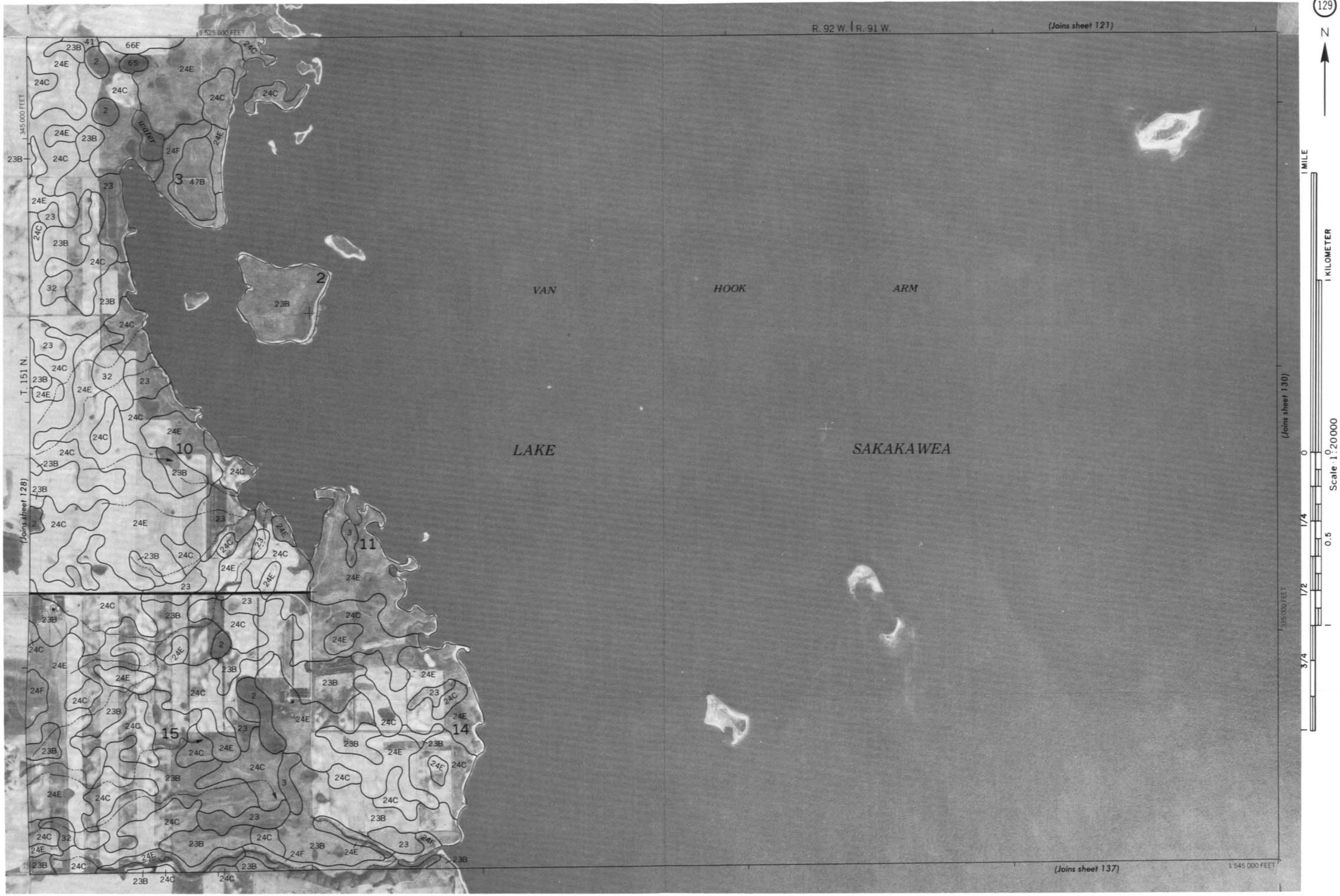
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 126

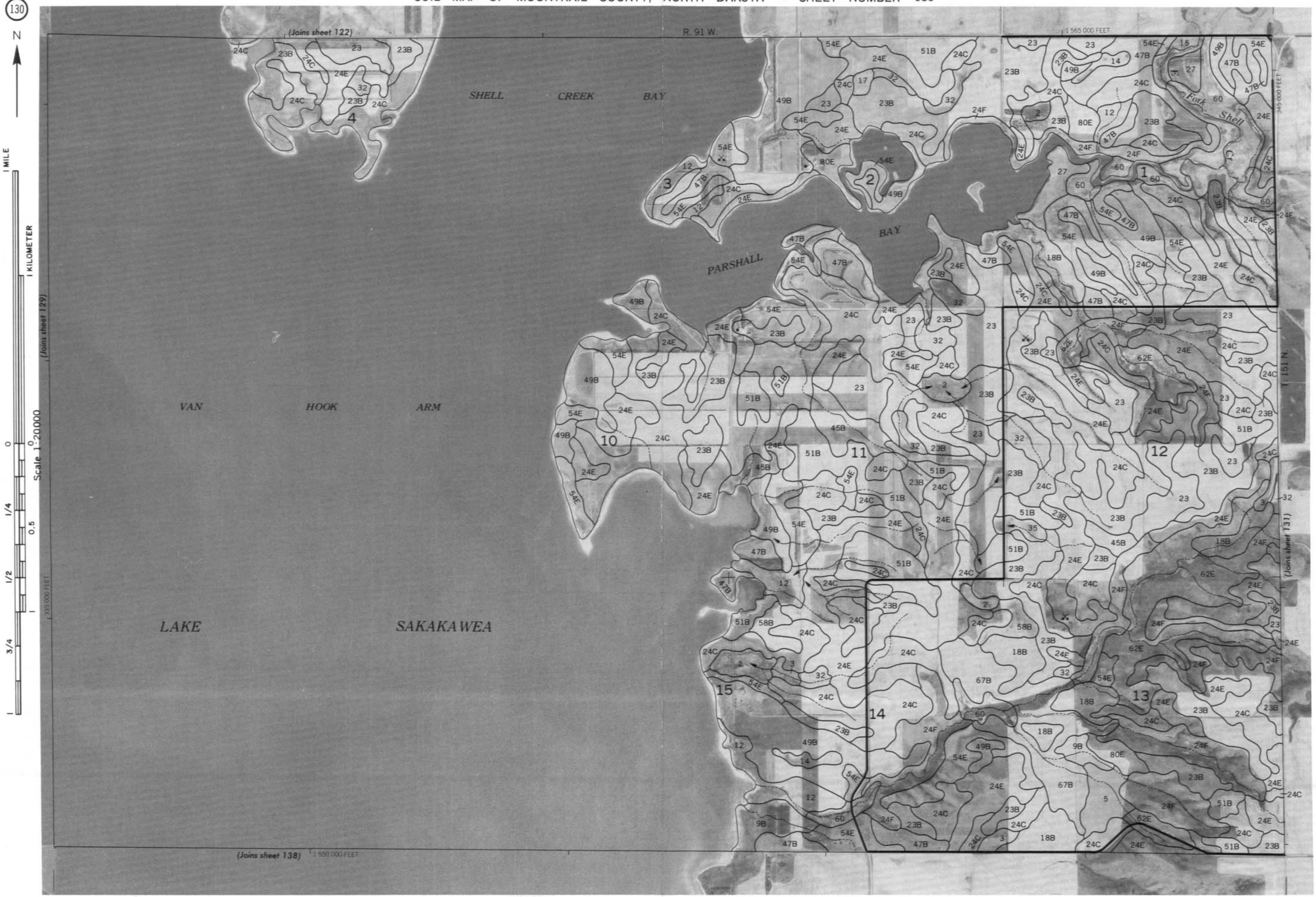



R. 93 W.
(Joins sheet 119)
(Joins sheet 128)
12 (Joins sheet 135)
T. 151 N.
1 475 000 FEET
355 000 FEET
345 000 FEET
1 495 000 FEET
McKENZIE
COUNTY
LAKE
SAKAKAWEA
REUNION
BAY
Grand Valley Church
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

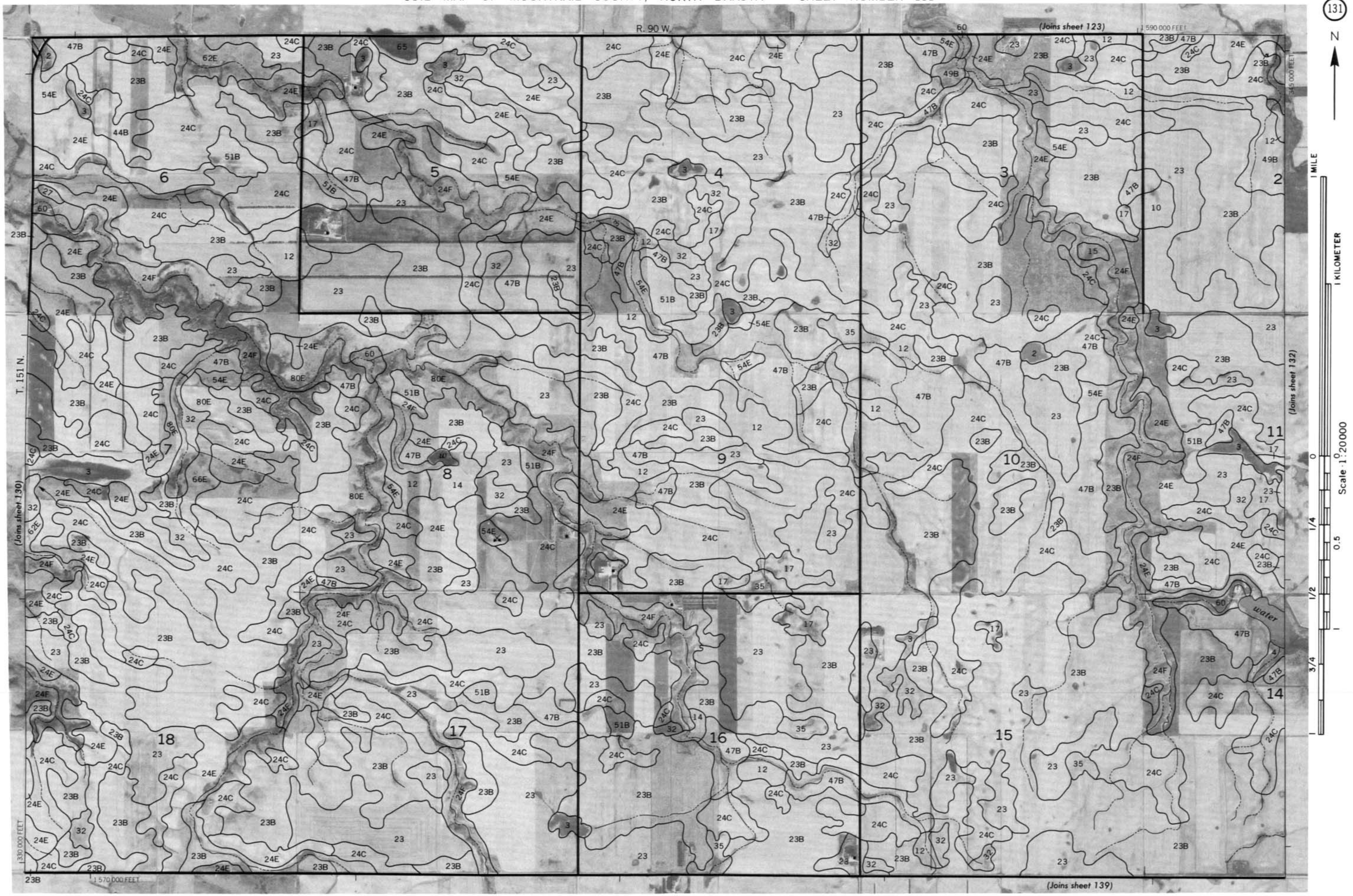
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 128

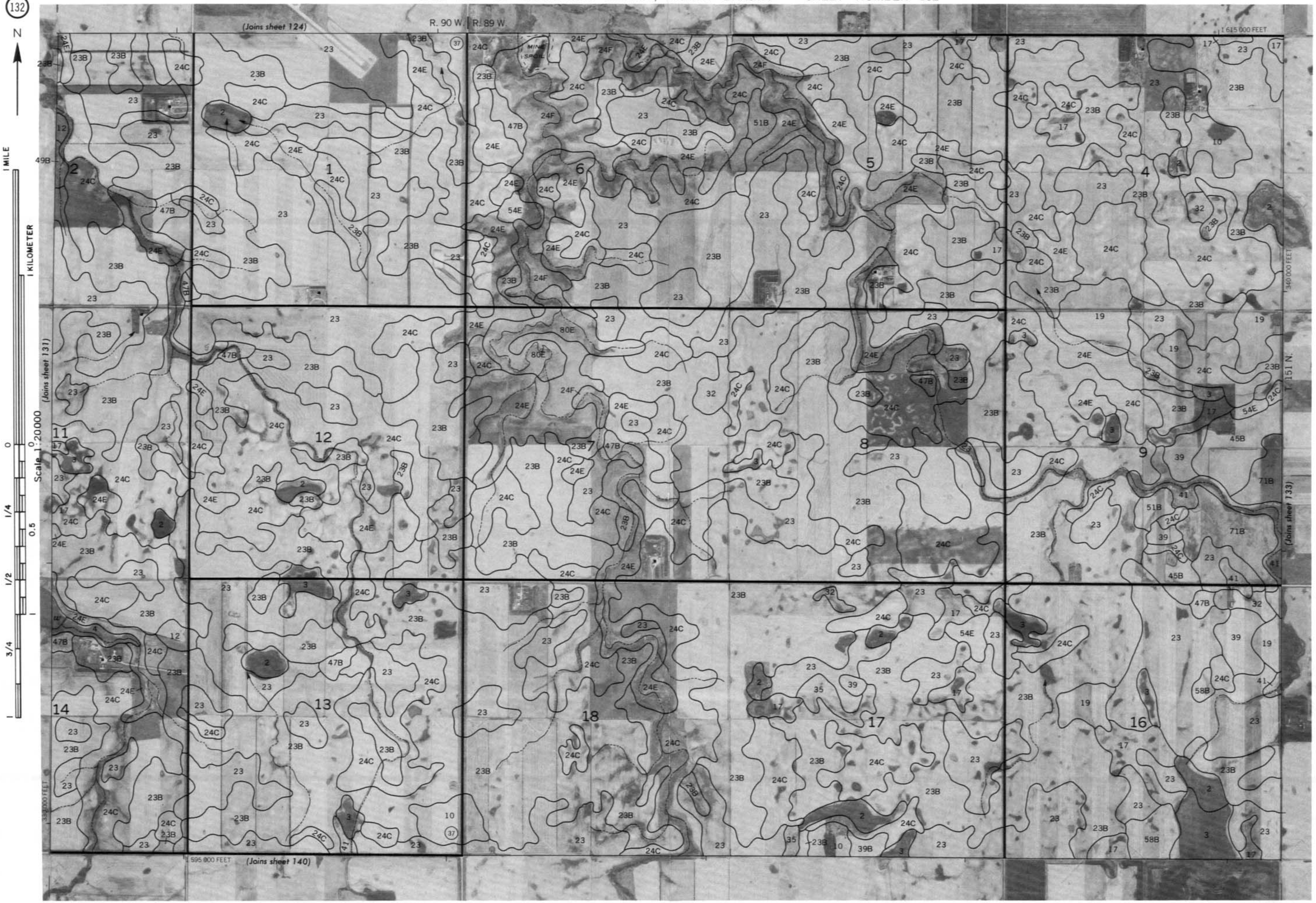



129
N
R. 92 W. | R. 91 W.
(Joins sheet 121)
(Joins sheet 128)
(Joins sheet 130)
(Joins sheet 137)
1 525 000 FEET
1 545 000 FEET
345 000 FEET
335 000 FEET
T. 151 N.
VAN HOOK ARM
LAKE SAKAKAWEA
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
2
3
10
11
14
15

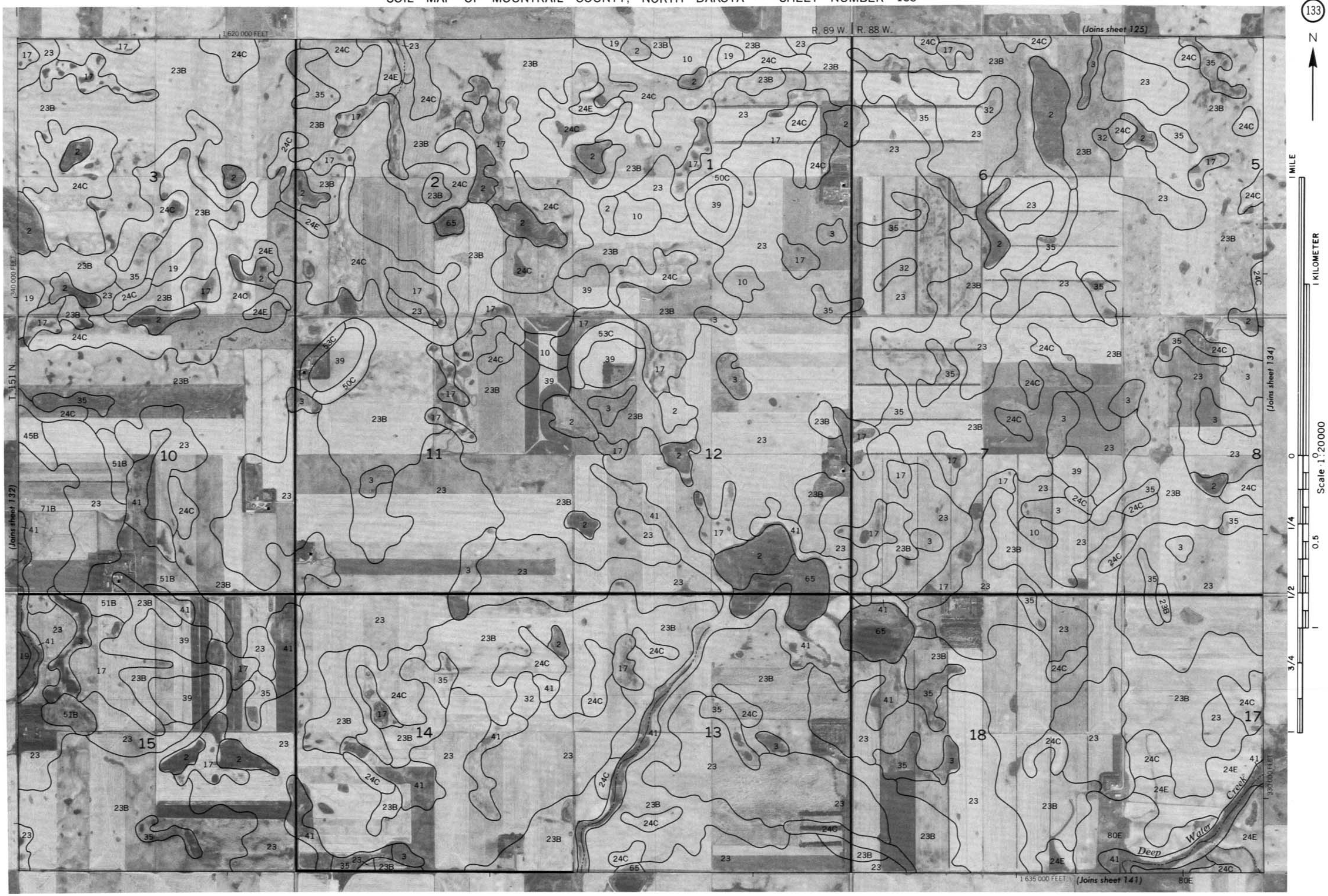

130
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 122)
R. 91 W.
1 565 000 FEET
SHELL
CREEK
BAY
PARSHALL
BAY
VAN
HOOK
ARM
LAKE
SAKAKAWEA
E. Fork Shell Cr.
(Joins sheet 129)
(Joins sheet 131)
(Joins sheet 138)
1 550 000 FEET
345 000 FEET
335 000 FEET
T. 151 N.
1
2
3
4
10
11
12
13
14
15

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 131

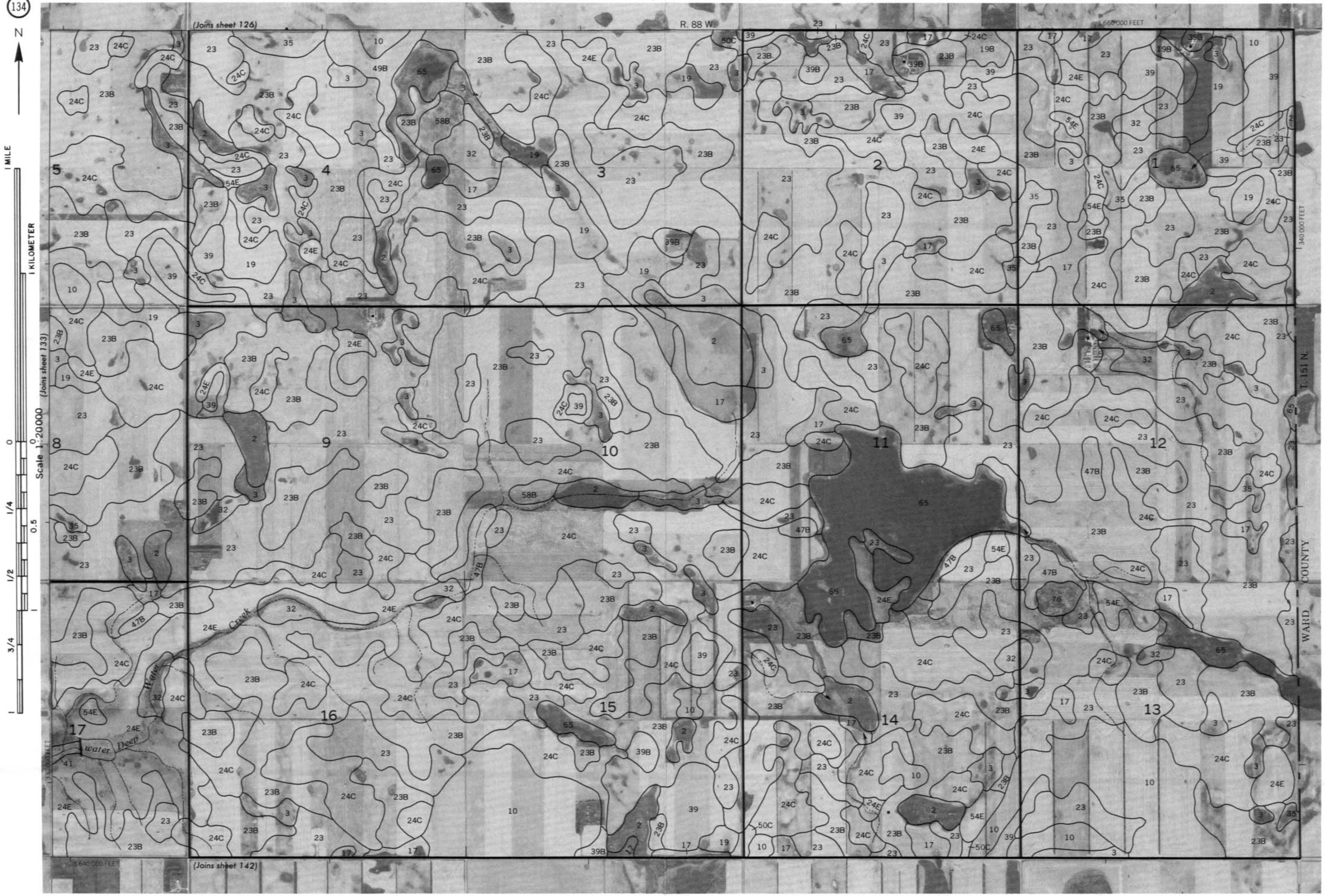



132
N
(Joins sheet 124)
R. 90 W.
R. 89 W.
1 615 000 FEET
MINE SPOIL
340 000 FEET
T. 151 N.
(Joins sheet 131)
(Joins sheet 133)
(Joins sheet 140)
1 595 000 FEET
330 000 FEET
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0.5
1
2
3
4
5
6
7
8
9
10
11
12
13
14
16
17
18

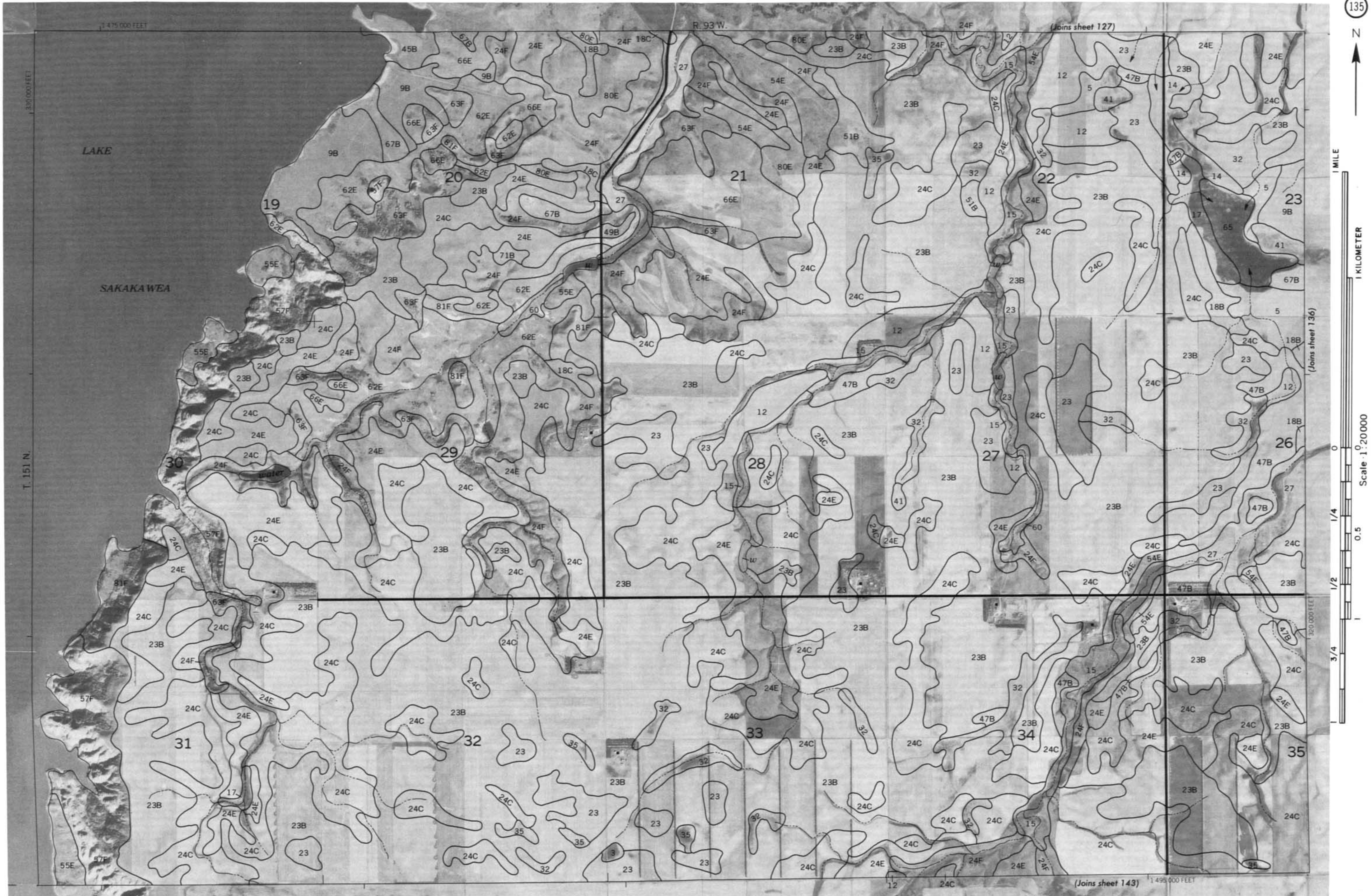
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 133



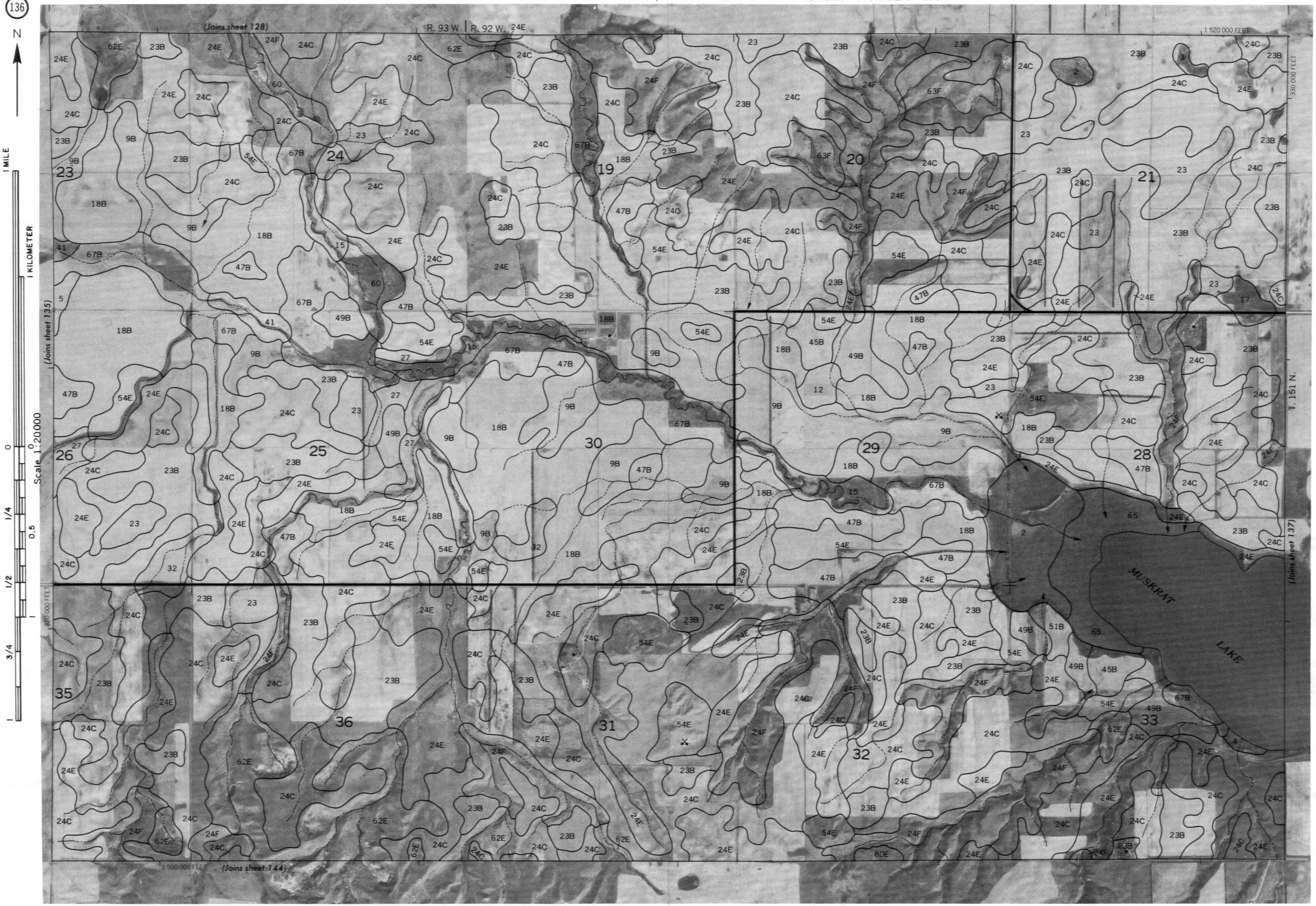
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 134



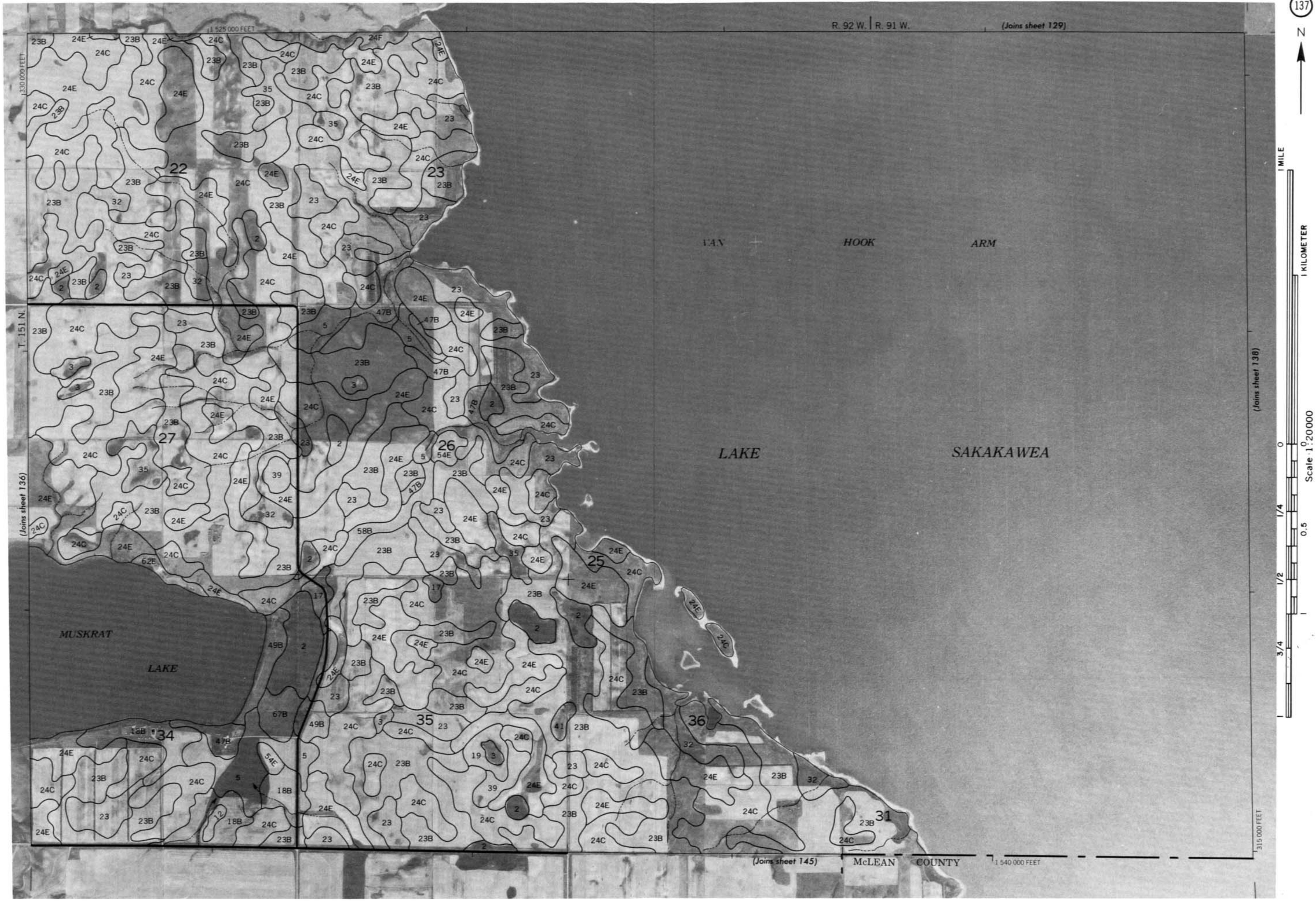
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 135

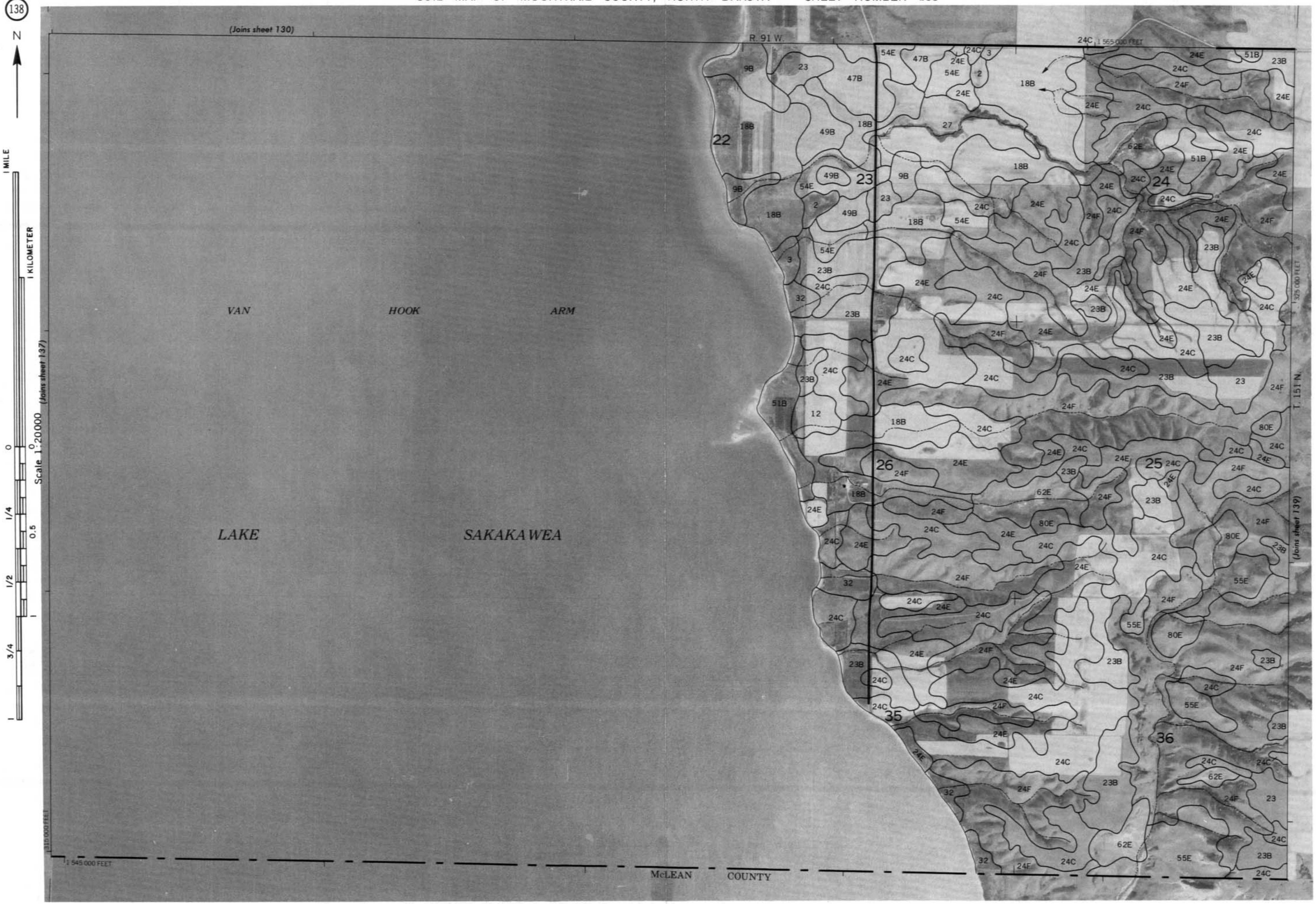


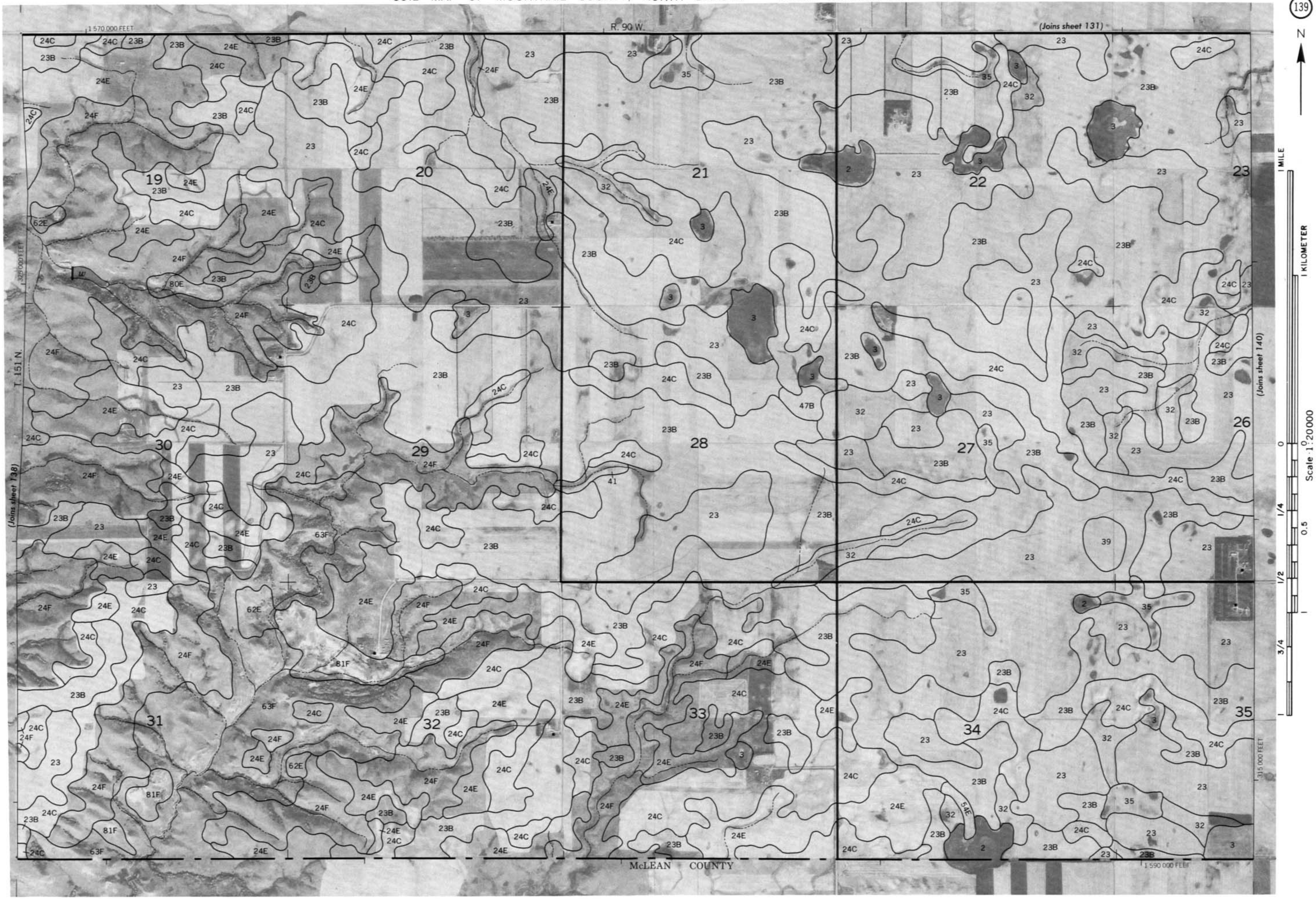
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 136



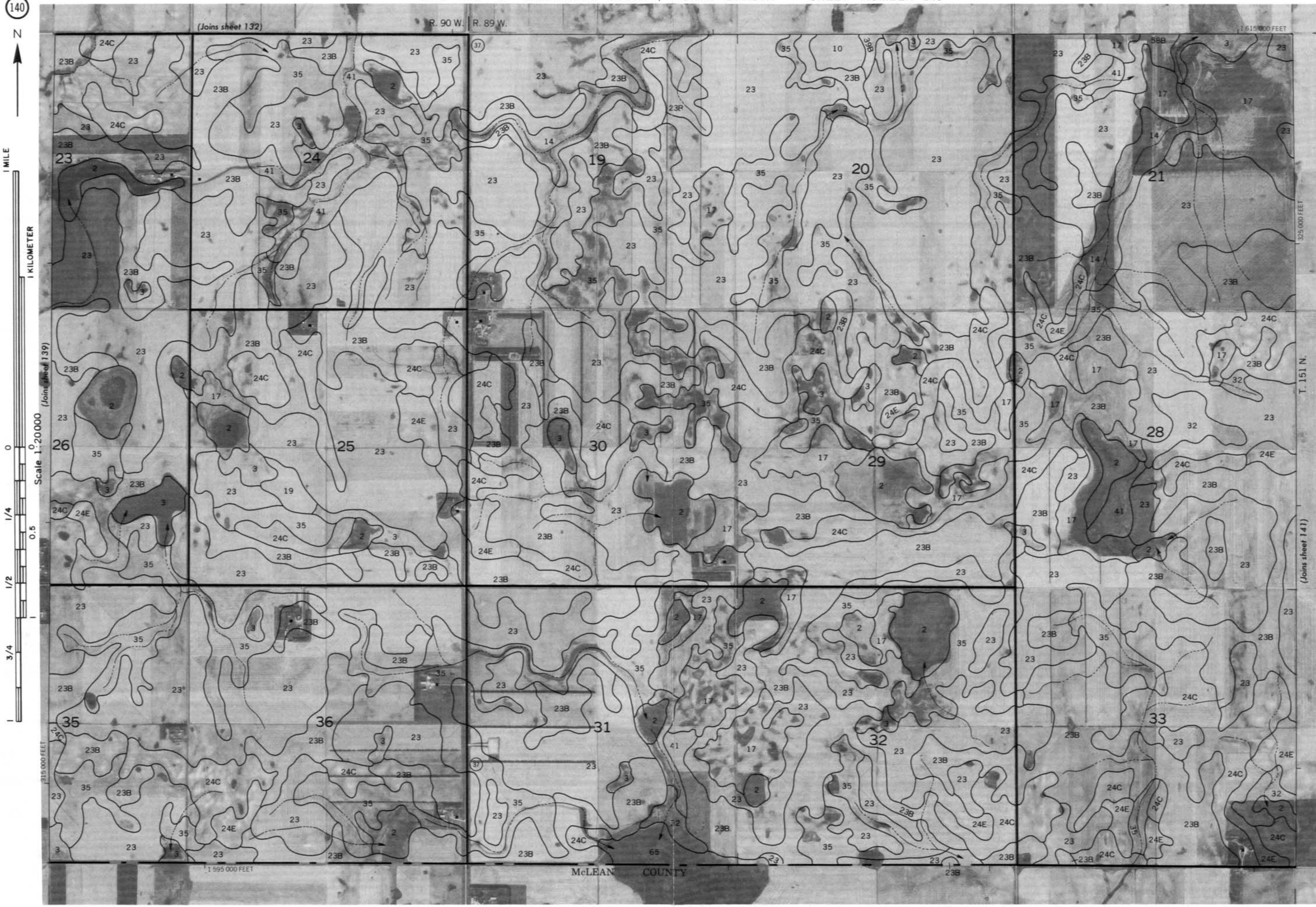
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 137

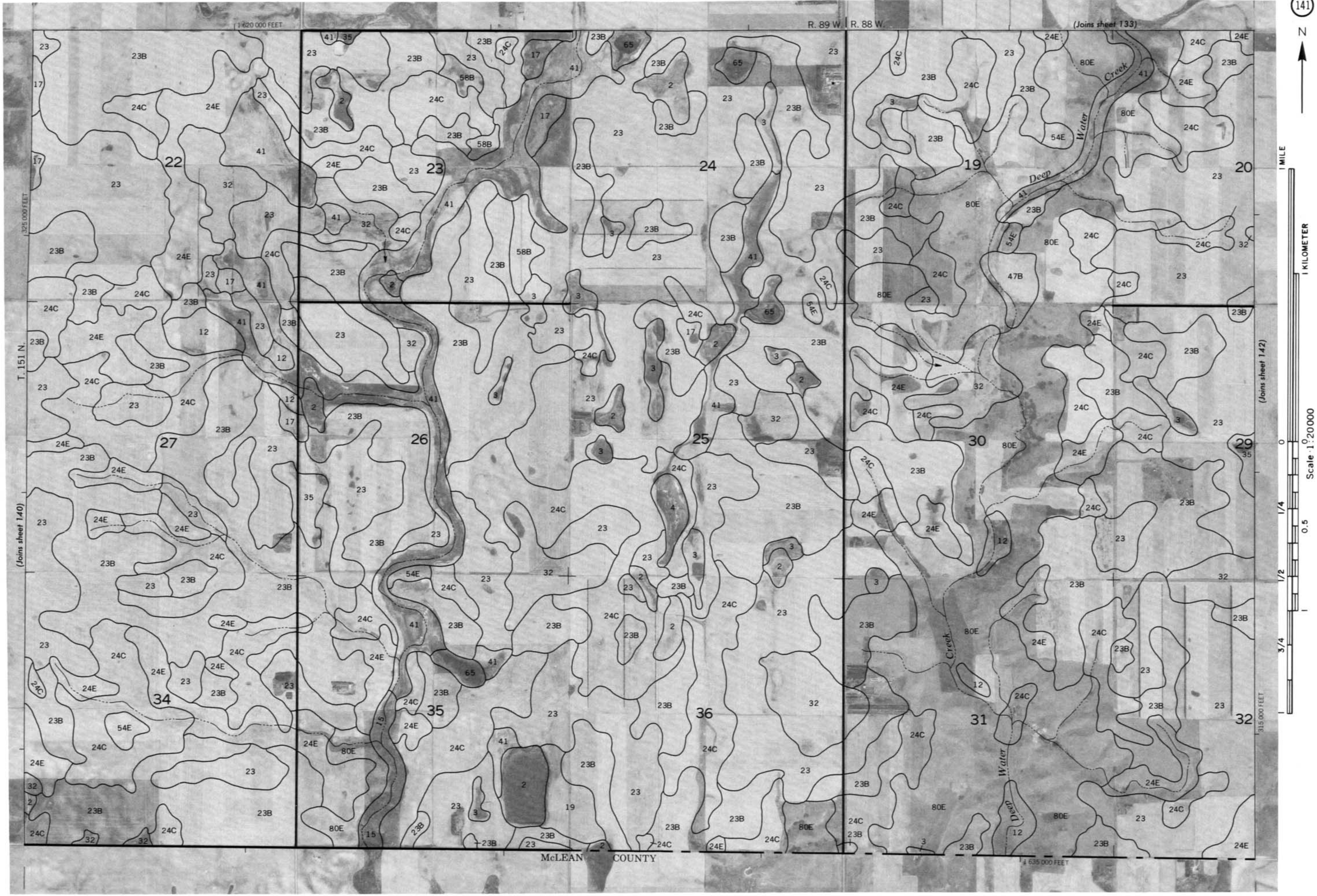



138
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
(Joins sheet 130)
(Joins sheet 137)
(Joins sheet 139)
R. 91 W.
T. 151 N.
1 565 000 FEET
325 000 FEET
315 000 FEET
1 545 000 FEET
VAN HOOK ARM
LAKE SAKAKAWEA
McLEAN COUNTY
22
23
24
25
26
35
36

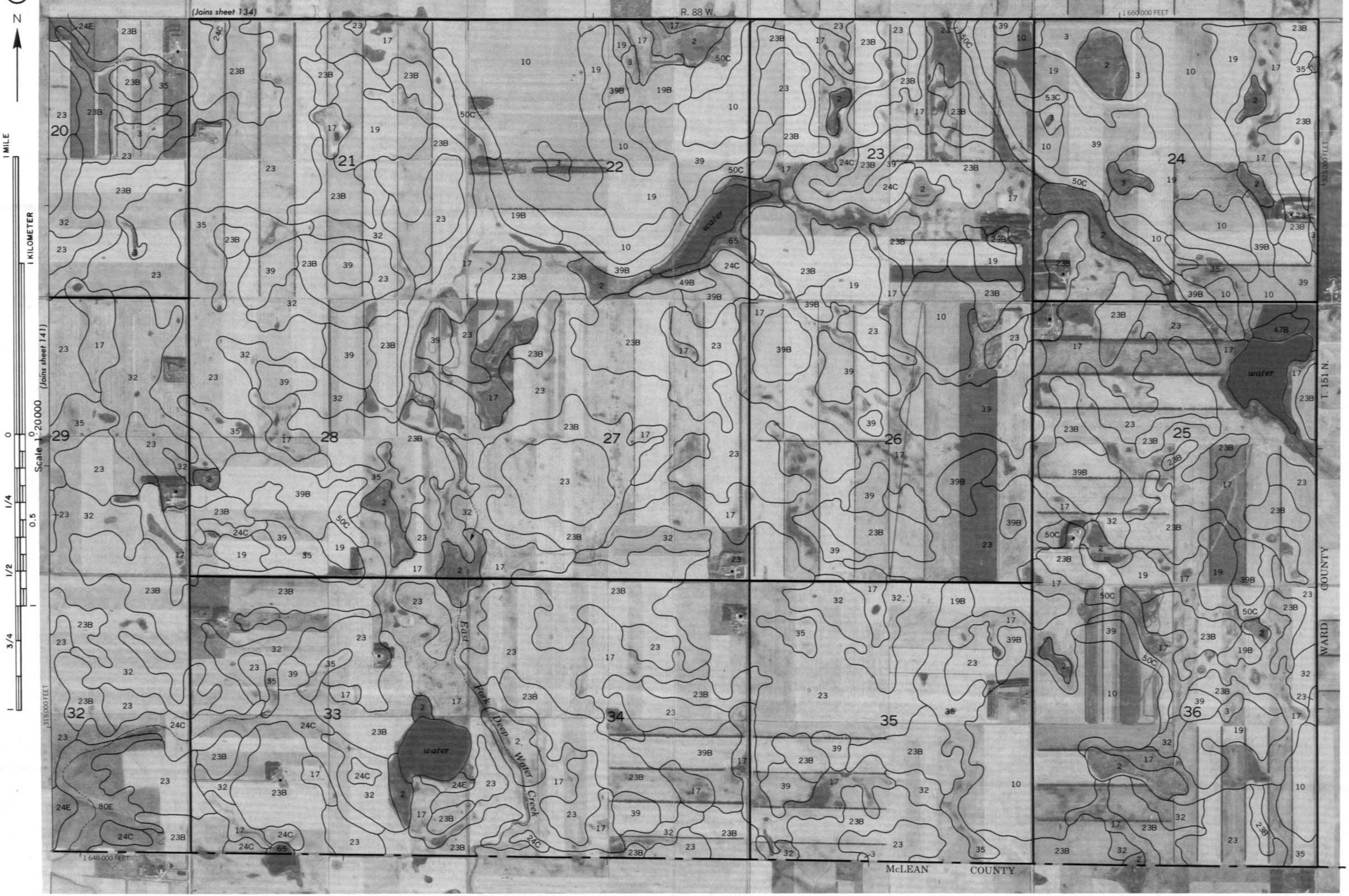

139
N
R. 90 W.
(Joins sheet 131)
(Joins sheet 138)
(Joins sheet 140)
T. 151 N.
McLEAN COUNTY
1 570 000 FEET
1 590 000 FEET
325 000 FEET
315 000 FEET
1 MILE
1 KILOMETER
Scale 1: 20000
0
1/4
1/2
3/4
0.5
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 140



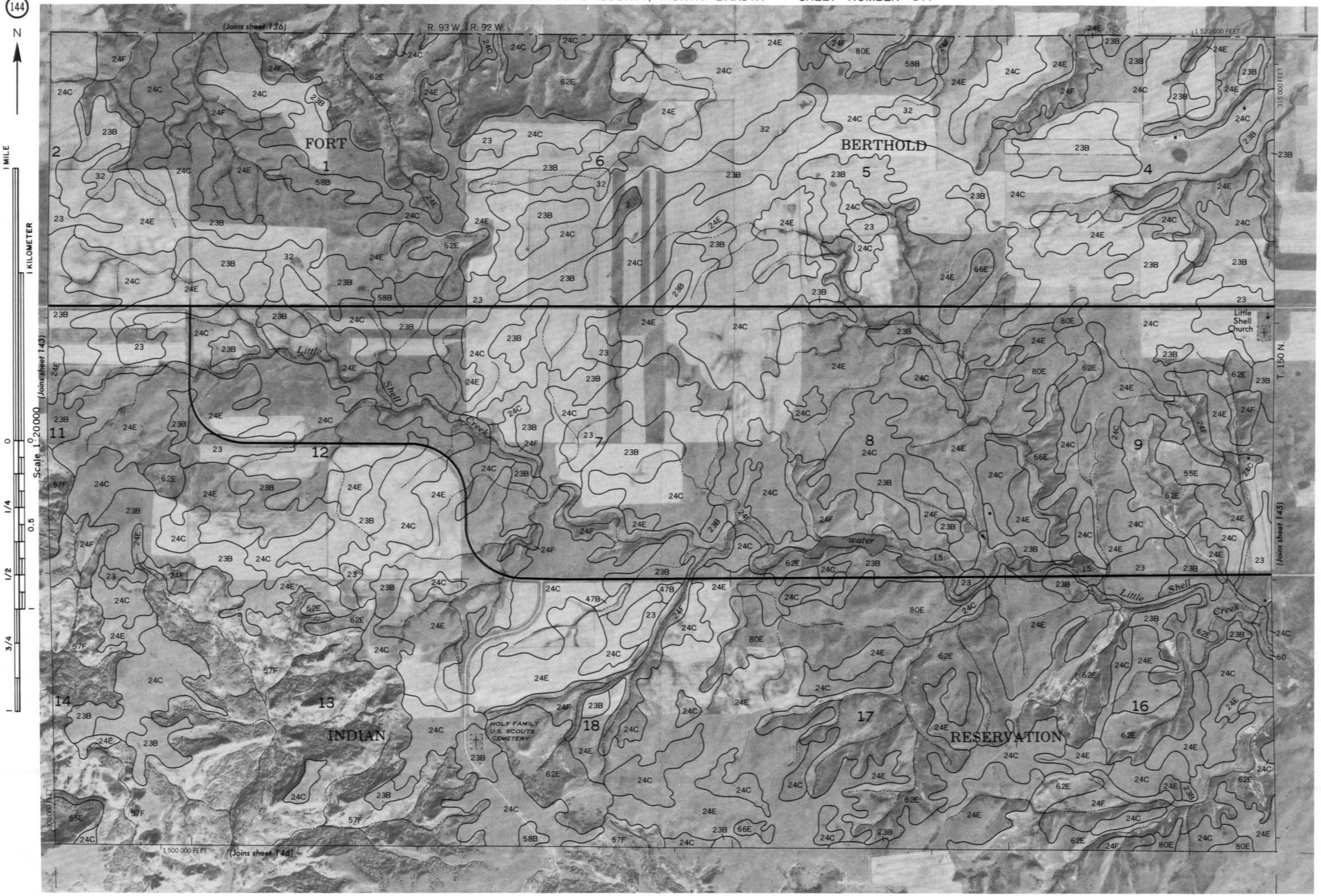

141
N
1 620 000 FEET
R. 89 W. | R. 88 W.
(Joins sheet 133)
T. 151 N.
325 000 FEET
(Joins sheet 140)
(Joins sheet 142)
315 000 FEET
McLEAN COUNTY
1 635 000 FEET
Deep Water Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 142

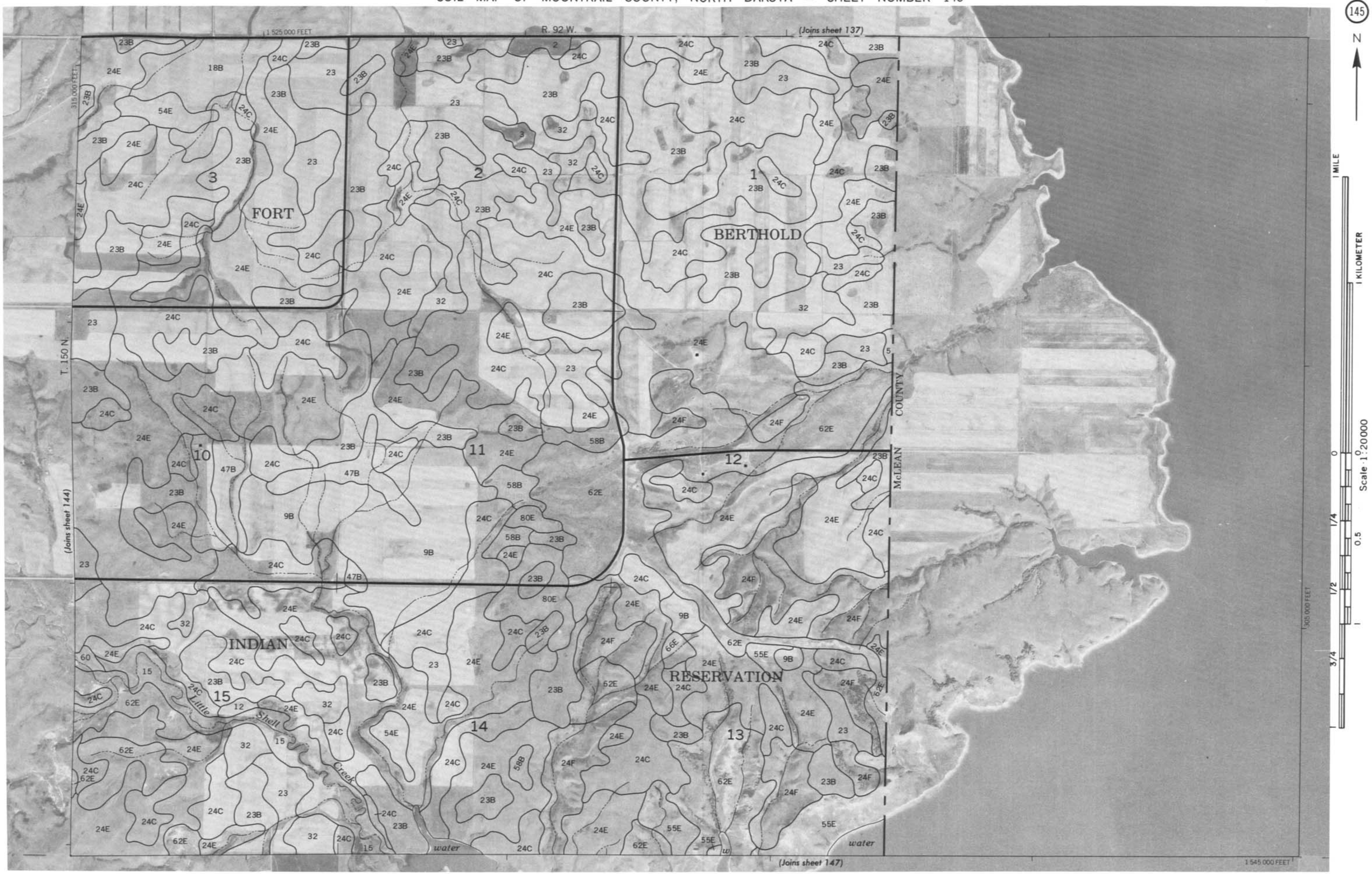


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 143

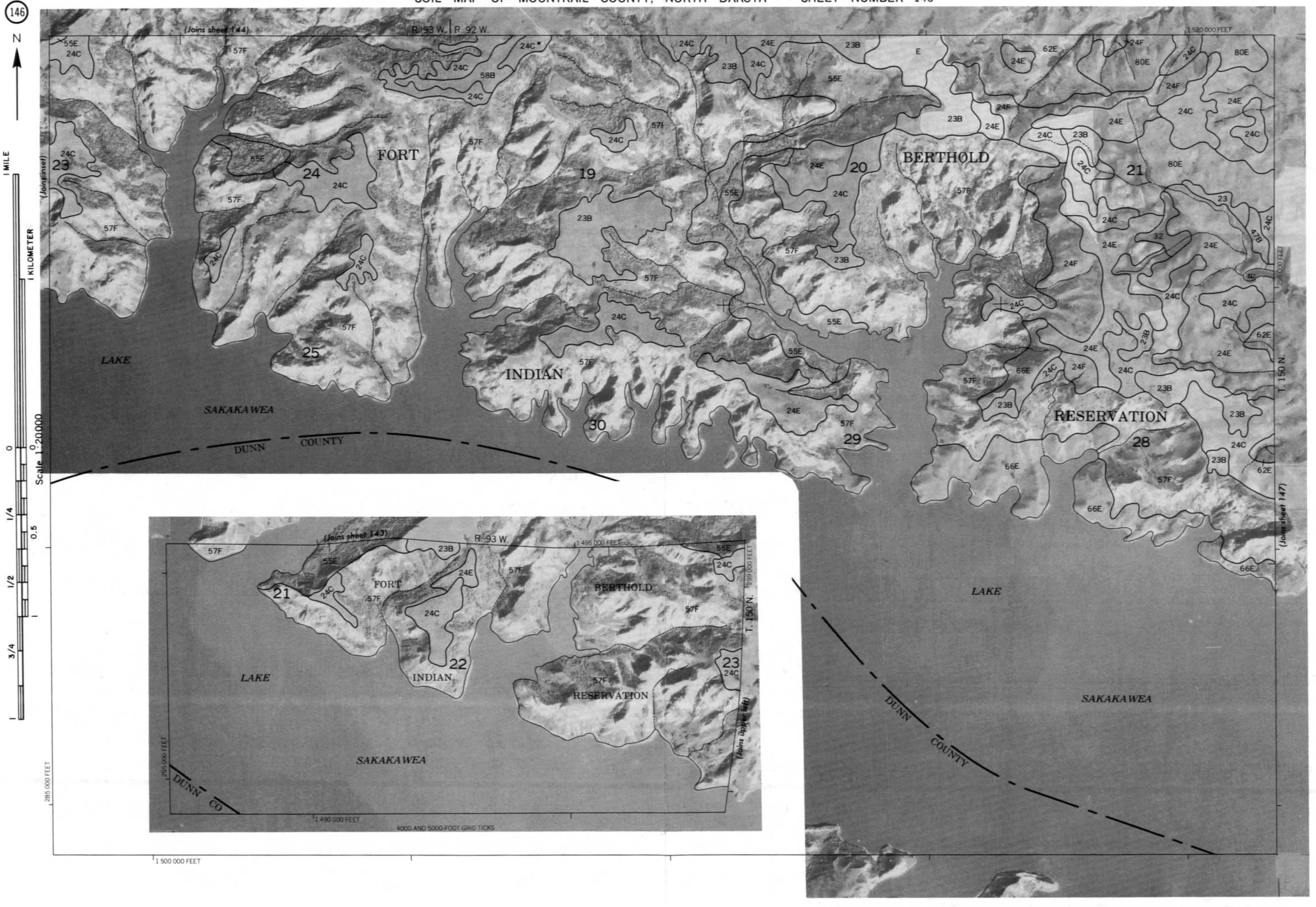
SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 144

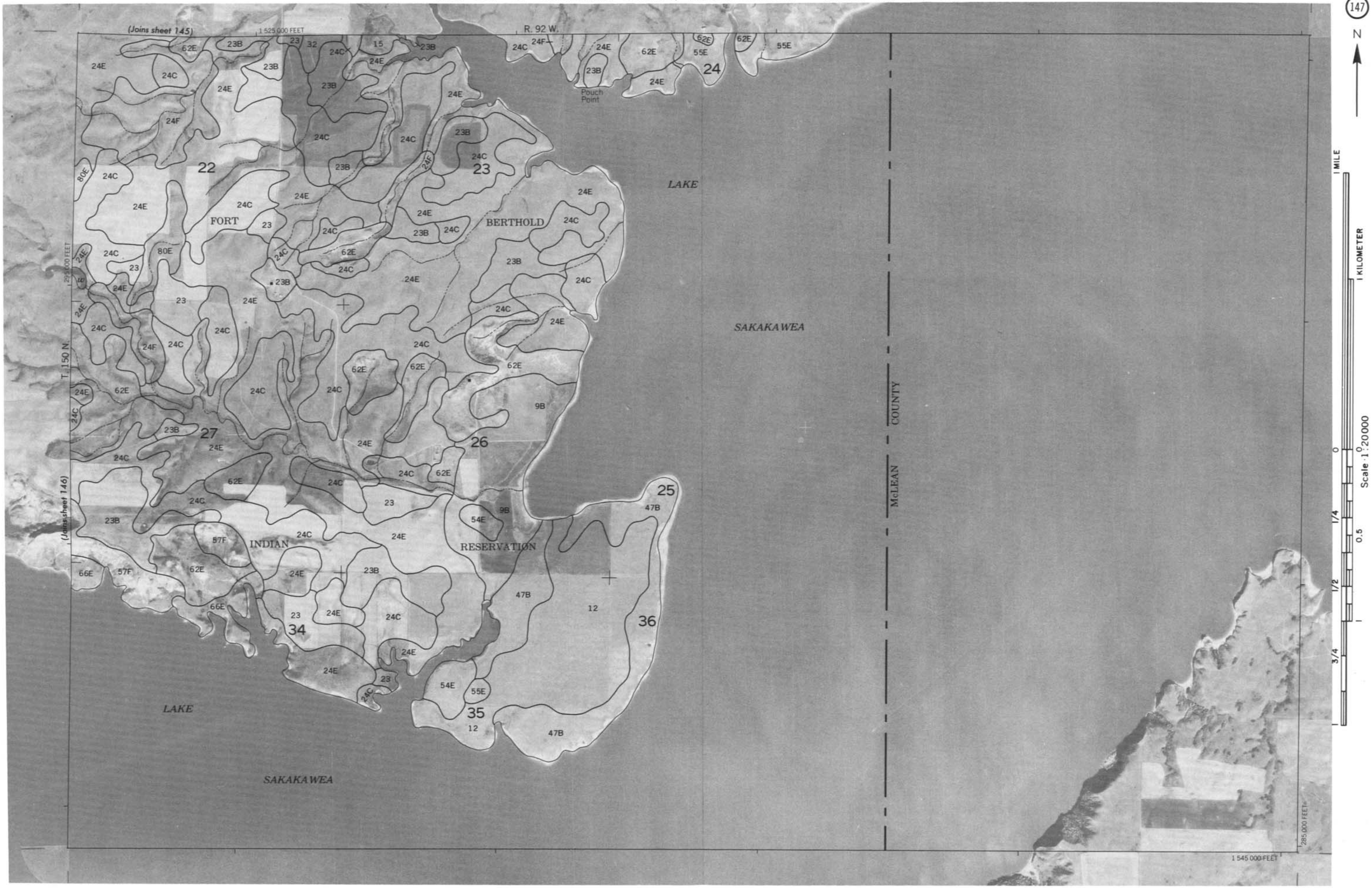


SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 145



SOIL MAP OF MOUNTRAIL COUNTY, NORTH DAKOTA — SHEET NUMBER 146




147
N
(Joins sheet 145)
1 525 000 FEET
R. 92 W.
(Joins sheet 146)
T. 150 N.
295 000 FEET
Pouch Point
LAKE
SAKAKAWEA
LAKE
SAKAKAWEA
FORT
BERTHOLD
INDIAN
RESERVATION
McLEAN
COUNTY
22
23
24
25
26
27
34
35
36
1 545 000 FEET
285 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
1